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THE EFFECTS OF AGE, SEX, AND RACE UPON THE ACETIC ACID FRACTIONS OF COLLAGEN (Human Biopsy-Connective Tissue)

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The morphologic and chemical changes of connective tissue serve as indicators of the aging process in the mammalian organism. Among the changes noted are the fraying of elastic fibers, the thickening of collagen fiber bundles, and a reduction in ground substance.

Aging changes in connective tissue of the arterial walls assume a special importance because of their possible relationship to the genesis of atherosclerosis. Aging results in intimal proliferation and in a reduction of the elastic properties of the media ostensibly due to collagen formation and replacement of the elastic fibers with the less elastic collagen fibers. The less elastic vessel which results is more susceptible to injury caused by excessive turbulence or blood jet streams. The response of the vessel wall to such injury is the formation of new connective tissue in the intima. Such localized intimal proliferation is one of the earliest stages in atherogenesis (17).

Vascular aging, as well as atherosclerosis, occurs to a greater degree in white males than in premenopausal white women. Epidemiologic studies of the atherosclerosis problem seem to indicate that the frequency of atherosclerosis is different among the races.

The present report deals with biochemical and physical chemical observations of connective tissue obtained from human subjects selected from various age and ethnic groups. The connective tissue employed in these studies was obtained from subcutaneously implanted Ivalon* sponges. This newly-formed connective tissue may be expected to provide an accurate reflection of the nature of connective tissue being laid down in the body under the influence of age and sex and from humans of various ethnic derivation.

METHODS

Connective tissue was obtained for the study by the sponge-biopsy technique (3) from white and Negro males of the Miami area and from male and female Eskimos and Indians of Alaska. The humans from the Alaskan area were divided for study into three age groups, i.e., young (9 to 14 years), middle-aged (20 to 40 years), and old (50 to 70 years). The whites and Negroes were in the middle-aged group. The sponge-biopsy was removed after 120 days of growth from all groups except from the old female Eskimo group, in which sponge age was 190 days.

The connective tissue biopsy was weighed and homogenized for 5 minutes in physiologic saline (pH 7.4) at 20,000 rpm in the VirTis Homogenizer at 5 C. The homogenate was centrifuged at 15,000 G. at 5 C. for 1 hour to yield a saline-soluble and a saline-insoluble fraction. The saline-soluble fraction contains the globular proteins and has the aromatic amino acid characteristics of ground substance; the saline-insoluble fraction contains the fibrous proteins and all of the hydroxyproline (5).

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* Clay-Adams, Inc., New York, N. Y.

The saline-insoluble residue was washed once with cold water and recentrifuged at 5 C. at 15,000 G. for 0.5 hour to remove salt. The residue was then placed in a tared lusteroid preparative ultracentrifuge tube and weighed to obtain the initial wet weight of the saline-insoluble tissue fraction. Five ml. of 0.5 M acetic acid were added, the tube capped and shaken for 24 hours at 5 C. The tube and its contents were then centrifuged in the ultracentrifuge at 90,000 G. for 1 hour. The volume of the clear supernate was measured, and the residue was resuspended in 5 ml. of 0.5 M acetic acid and shaken for 24 hours. The extraction and centrifugation were repeated at 24-hour intervals until the residue ceased to gain weight. The weight gain was the result of an absorption of acetic acid and a swelling of the scleroprotein. The total volume of the several extracts, 5 to 10 in number, comprised the acetic acid-soluble fraction of connective tissue. The residue which was obtained after the repeated extractions with acetic acid was termed the acetic acid-insoluble fraction.

Acetic Acid-Soluble Fraction of Connective Tissue Biopsy:

Nitrogen was determined on Kjeldahl digests by the microdiffusion technique of Conway (7). The nitrogen concentration of 3 to 5 of the individual 0.5 M acetic acid extracts was determined so that the amount of acetic acid-soluble protein material could be calculated. Nitrogen analysis was also made on the pooled sample of several extracts used for viscosity and sedimentation determinations. Hydroxyproline was determined colorimetrically by the method of Neuman and Logan (16) on acid hydrolysates of several individual extracts or on a pooled sample.

A 50 to 100 microliter aliquot of the acetic acid extract, containing 50 to 100 micrograms of protein, was applied to a paper electrophoresis strip saturated with acetate buffer, pH 3.5 and ionic strength 0.05. The strips were dyed for protein with a solution containing 0.25 Gm. aniline blue and 2 ml. glacial acetic acid per 100 ml. water. Carbohydrate was stained with periodic acid and fuchsin reagent (2) and the lipid with Oil Red 0 (2). The electrophoretic conditions and the analytic techniques have been described (12).

The viscosity of the acetic acid-soluble tissue fraction was determined by measurements of flow times of the extract pool in Ostwald-Fenske viscometers which had flow times of approximately 85 sec. All measurements were made at 7.0 ± 0.1 C. The reduced viscosity $\frac{(\eta_{sp})}{c}$ was plotted on the ordinate against concentration (c) in Gm. per 100 ml. on the abscissa. The y-intercept, is the intrinsic viscosity (η), and the slope is the interaction term (A_1).

The interpretation of the term A_1 was based on the work of Cragg and Bigelow (8). A positive A_1 implies interaction or attraction between molecular pairs while a negative term indicates a repulsion.

The axial ration (J) of the material in solution was obtained from a graph of $\frac{(\eta_{sp})}{(\emptyset)}\emptyset = 0$ as a function of J according to Simha (18), where $\emptyset$ is the volume fraction of protein.

Analytic sedimentation data on the acetic acid extract were obtained in the Spinco analytic ultracentrifuge equipped with Schlieren optics and a special temperature indicating device. Analyses were made at 250,000 G. and at a temperature of from 7.0 ± 0.1 C. to 12.0 ± 0.1 C. Twelve photographs were made at intervals at 16 min. on each of 6 dilutions of the sample. The sedimentation coefficients were obtained graphically and were corrected to the density and viscosity constants for water at 20 C. The concentration dependence was determined by plotting $1/S_{20}$ against c, and S°_{20} was obtained by extrapolating to infinite dilution.

Estimations of the molecular weight of the acetic acid-soluble material were made by using the Mandelkern equation with the sedimentation velocity and intrinsic viscosity data (14). The partial volume term for the protein was assumed to be 0.7, the solvent density was 1.00, and the solvent viscosity was 0.0109 poise. The constant term in the Mandelkern equation was 2.3×10^6.

In the calculation of the quantity of protein solubilized by acetic acid, the fact that the concentration of protein in any individual acetic acid extract up to the complete dissolution of the soluble tissue fraction fits the equation $C = C_1 e^{-Kv(n-1)}$ was developed and employed. C is the concentration of protein in mg. per ml. at extraction n, and C_1 is the concentration at extract $n = 1$. K is a dissociation tendency of the protein and v, the average volume of the extracts obtained from the repeated extractions.

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The total amount of protein solubilized was estimated from the line of log C versus n. Protein concentration of each of the extracts was estimated from this linear regression line and the concentrations summated. This sum was multiplied by v to obtain the total amount of protein solubilized.

Acetic Acid-Insoluble Fraction of Connective Tissue Biopsy:

In the determination of the swelling characteristics of the fibrous portion of the connective tissue biopsy, the saline-insoluble residues were weighed prior to the addition of the acetic acid and after each 24-hour extraction period until the increase in weight ceased and equilibrium was reached. The logarithm of the weight of the tissue after each extraction was plotted against the logarithm of the total time of exposure to the solvent (20). There was usually a linear increase in weight of the residue during the first 4 extractions. The weight increase then leveled and approached equilibrium. The final weight at equilibrium was obtained from an average of the last 5 points of the flat portion of the curve. The ratio, weight at equilibrium/initial weight, was used as an approximation of the ratio of the volume at equilibrium to the initial volume.

The acetic acid-insoluble fraction was hydrolyzed with 6 N HCl for 17 hours at 110 C., and nitrogen and hydroxyproline analyses were made on the hydrolysate.

In the calculation of the composition of the protein of the acetic acid-soluble and acetic acid-insoluble fractions, it was assumed that the collagen of the fractions had a hydroxyproline concentration of approximately 13.4 per cent. Thus, the concentration of hydroxyproline in each of the fractions was multiplied by 7.46 (16), and the resultant collagen value was subtracted from the total protein concentration of the fraction to obtain the non-collagen protein.

RESULTS

The Acetic Acid-Soluble Fraction:

Characteristics.—The acetic acid-soluble fraction seems to consist of a collagenous and a non-collagenous protein the percentage distribution of which varied within the ethnic groups (table 1). The acetic acid-soluble fraction was characterized electrophoretically as a single boundary which moved toward the cathode and was accompanied by carbohydrate and

TABLE 1. ACETIC ACID FRACTIONATION OF THE SCLEROPROTEIN OF HUMAN CONNECTIVE TISSUE. MALES.
(AGE 20 TO 40)
mg./Gm. Tissue.

Race	Acetic Acid-Soluble Fraction			
	Total Protein	Collagen	Non-Collagen Protein	% Collag n
Alaskan Indian	20.38±7.02*	1.65± 1.30	18.73± 2.63	22.49± 8 17
Negro	13.37± 1.19	5.13± 3.29	8.24± 1.59	37.65±16 19
White	21.54± 5.99	5.63± 2.64	15.91± 3.71	25.44± 5 54
Alaskan Eskimo	30.95± 3.70	11.02± 3.13	19.93± 6.04	36.36±13 31
	Acetic Acid-Insoluble Fraction			
Alaskan Indian	43.14± 9.98	20.59±11.71	22.54± 1.73	45.82±16.55
Negro	68.96±22.31	42.60±22.20	26.36± 0.24	58.93±13.38
White	60.94±18.10	31.14± 9.36	29.80± 9.27	51.05± 4.19
Alaskan Eskimo	46.60± 7.09	26.71± 4.85	23.12± 1.29	53.40± 3.15

* Mean and standard deviation of the mean.

TABLE 2. PHYSICAL CHEMICAL PROPERTIES OF THE ACETIC ACID-SOLUBLE FRACTION.
Human Connective Tissue.

Sex, Race, and Age	(η)	S°_{20}	M_w	J	A_1
Male Alaskan Eskimo					
Years 9-1-13	0.5	2.69×10^{-13}	96,000	28	.....
Years 19-20-43	2.7	2.60	221,000	84	3.0
Years 56-66-66	4.7	3.44	427.000	125	12.0
Female Alaskan Eskimo					
Years 11-12-12	4.3	2.93	322,000	102	0.0
Years 25-35	4.6	2.35	239,000	108	5.0
Years 60-65	4.7	2.16	213,000	112	8.8
Male Alaskan Indian					
Years 10-14	0.6	2.20	81,200	34	0.0
Years 24-40	2.6	2.01	139,000	61	.....
Years 58-59-65	4.5	2.06	193,000	134	2.2
Female Alaskan Indian					
Years 9-13	2.4	1.82	119,000	73	1.2
Years 28-35-36	0.6	1.92	64,000	33	0.9
Years 49-67-70	2.8	2.02	192,000	80	1.7
Male Negro					
Years 29-30-45	3.1	2.70	199,000	80	7.9
Male White					
Years 25-28-30	2.5	2.03	139,000	74	0.0

(η) = Intrinsic Viscosity
S°_{20} = Sedimentation Coefficient
M_w = Molecular Weight
J = Axial Ratio
A_1 = Interaction Term

TABLE 3. ACETIC ACID-SOLUBLE FRACTION OF HUMAN CONNECTIVE TISSUE.

mg./Gm. Tissue.

Sex, Race, and Age	Total Protein	Collagen	Non-Collagen Protein	% Collagen
Male Alaskan Eskimo				
Years 9-11-13	.....	.....	.....	.....
Years 19-20-43	30.95 ± 3.70*	11.02 ± 3.13	19.93 ± 6.04	36.36 ±13.31
Years 56-66-66	46.42 ± 7.07	12.83 ± 3.25	33.51 ± 2.89	27.35 ± 3.25
Female Alaskan Eskimo				
Years 11-12-12	17.22 ± 3.09	3.31 ± 0.88	13.91 ± 2.95	19.51 ± 2.56
Years 25-35	17.14 ± 3.43	2.50 ± 0.93	14.63 ± 5.63	15.97 ± 9.90
Years 60-65	54.87 ±17.41	8.20 ± 5.21	46.71 ±12.15	14.14 ± 5.00
Male Alaskan Indian				
Years 10-14	20.76 ± 3.07	6.25 ± 2.37	14.52 ± 1.73	31.26 ± 7.57
Years 24-40	20.38 ± 7.02	1.65 ± 1.30	18.73 ± 2.63	22.49 ± 8.17
Years 58-59-65	20.42 ± 5.49	4.62 ± 2.25	15.74 ± 2.71	21.86 ± 8.22
Female Alaskan Indian				
Years 9-13	16.58 ± 3.17	2.80 ± 1.66	13.78 ± 1.59	16.19 ± 6.86
Years 28-35-36	16.03 ± 2.45	3.42 ± 0.77	12.61 ± 1.70	21.17 ± 1.39
Years 49-67-70	17.20 ± 1.57	2.82 ± 0.32	14.38 ± 1.68	16.48 ± 1.03

* Mean and standard deviation of the mean.

TABLE 4. ACETIC ACID-INSOLUBLE FRACTION OF HUMAN CONNECTIVE TISSUE.

mg./Gm. Tissue.

Sex, Race, and Age	Total Protein	Collagen	Non-Collagen Protein	% Collagen
Male Alaskan Eskimo				
Years 9-11-13	.....	.....	.....	.....
Years 19-20-43	46.60 ± 7.09*	26.71 ± 4.85	23.12 ± 1.29	53.40 ± 3.15
Years 56-66-66	48.30 ± 5.66	30.36 ± 3.52	17.93 + 2.81	62.93 ± 3.18
Female Alaskan Eskimo				
Years 11-12-12	56.58 ± 4.17	31.11 ±12.70	25.47 ± 4.11	53.76 ± 7.10
Years 25-35	55.28 ± 0.20	33.16 ± 1.53	22.12 ± 1.74	60.00 ± 2.98
Years 60-65	82.60 ±10.40	56.40 ± 4.81	26.28 ± 4.81	68.33 ± 1.83
Male Alaskan Indian				
Years 10-14	39.90 ± 5.68	24.15 ± 3.20	15.76 ± 8.88	61.70 ±16.81
Years 24-40	43.14 ± 9.98	20.59 ±11.71	22.54 ± 1.73	45.82 ±16.55
Years 58-59-65	73.61 ±23.88	42.99 ±24.61	30.62 ±16.44	57.58 ±20.02
Female Alaskan Indian				
Years 9-13	27.60 ± 8.12	11.94 ± 6.85	15.67 ± 1.60	58.96 ±12.20
Years 28-35-36	50.39 ± 6.98	25.66 ± 5.75	24.73 ± 1.54	49.50 ± 5.05
Years 49-67-70	34.36 ±14.01	14.57 ± 6.33	23.13 ±13.40	53.44 ± 8.85

* Mean and standard deviation of the mean.

lipid. The solubilized material after filtration through sintered glass of fine porosity moved as a sharp, discrete peak in the ultracentrifuge indicating monodispersity of the material (fig. 1). The intrinsic viscosity of this fraction had an average value of 4.0. The sedimentation coefficient averaged 2.4 x 10^{-13} and the calculated molecular weight was approximately 200,000 (table 2).

Effects of sex of the donor upon the acetic acid-soluble fraction. — The total and the acetic acid-soluble collagen concentrations were greater in the biopsy-connective tissue of the human male than in that of the female with the exception of the 60 to 65-year-old female group of Eskimos, in which the total collagen was greater than in this age group of male Eskimos (tables 3 and 4). The tissue from the old female Eskimos was older (190 days) than that obtained from the old age male Eskimos.

In the 24 to 40-year-old group of Indians, the female seemed to have slightly greater concentrations of total and acid-soluble collagen than in the male.

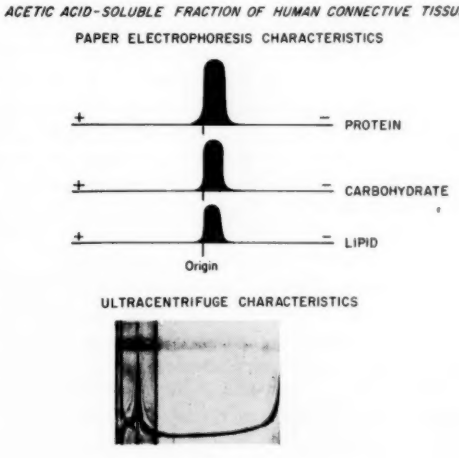

Figure 1.

Effects of the age of the human donor upon the acetic acid-soluble fraction.—The effects of the donor age upon the acetic acid-soluble fraction of the biopsy-connective tissues are best illustrated in the Eskimos (table 3). The acetic acid-soluble fraction of the old age group of males and females contained the greatest total protein concentration. The increase in the solubilized protein in the male with age was due only to an elevation of non-collagenous protein; the collagenous protein remained unchanged. The collagen and the non-collagenous proteins of the 60 to 65-year-old group of female Eskimos were both increased in concentration.

Connective tissue from the Indians did not reveal any change in the total acetic acid-soluble protein concentrations with increasing age of the donor (table 3).

The physical chemical characteristics of the acetic acid-soluble fraction were influenced by the age of the tissue donor. For example, as the males aged, there were increases in the intrinsic viscosity, in the sedimentation coefficient, in the molecular weight, in the axial ratio, and in the interaction term A_1 (table 2, Eskimo and Indian males). The physical chemical characteristics of the soluble tissue fraction of the females had less striking changes with age (table 2, Eskimo and Indian females). In fact, sedimentation coefficient and molecular weight of the acetic acid extract of the tissue of the Eskimo female decreased with age.

Effects of ethnic derivation upon the acetic acid-soluble fraction.—The acetic acid-soluble fraction differed in composition in the 4 races studied. The concentration of solubilized collagen was lowest in the Indian and greatest in the Eskimo. Non-collagen protein concentration was low in the Negro and relatively constant in the 3 other groups of middle-aged males (table 1).

A comparison of the physical chemical characteristics of the acetic acid-soluble tissue fractions of the Eskimo, Indian, Negro, and white middle-aged males indicated a general similarity. The molecular weight of the acid extract of the connective tissue of the Eskimos, 221,000, seemed to be higher than that of the 3 other races (table 2).

The Acetic Acid-Insoluble Fraction:

Characteristics.—The scleroprotein residue of the connective tissue biopsy which remained after repeated extractions with acetic acid had higher concentrations of hydroxyproline and of total protein than did the acetic acid-soluble tissue fraction (tables 3 and 4). Thus, the acetic acid-insoluble tissue fraction had a greater concentration of collagen (approximately 25 mg./Gm. tissue) and the protein of this fraction contained a larger percentage of collagen (55%) than did the acetic acid-soluble fraction.

The effects of donor age upon the acetic acid-insoluble fraction.—A comparison of the acetic acid-insoluble fractions obtained from the different age groups of male and female Eskimos and Indians was made in table 4. A greater concentration of total protein was found in the 60 to 65-year-old group of female Eskimos and in the 58 to 65-year-old group of male Indians than in their younger age groups. The collagen concentration seemed to increase with age in the acetic acid-insoluble fraction of the tissue from the Eskimos and from the male Indians. In the Eskimo connective tissues, it seemed that as collagen concentration in the acetic acid-insoluble fraction increased with age the concentration of non-collagenous protein remained constant. This change effected an increase in the percentage of collagen in the total protein of the acetic acid-insoluble tissue fraction with age.

The serial acetic acid extractions and weighings of the acetic acid-insoluble residue permitted the measurement of the swelling of the scleroprotein. Figure 2 graphically depicts the differences in the swelling characteristics of the acetic acid-insoluble tissue fractions of the different age groups of male and female Indians. The ratio, equilibrium volume/initial volume, seemed to decrease gradually in the acetic acid-

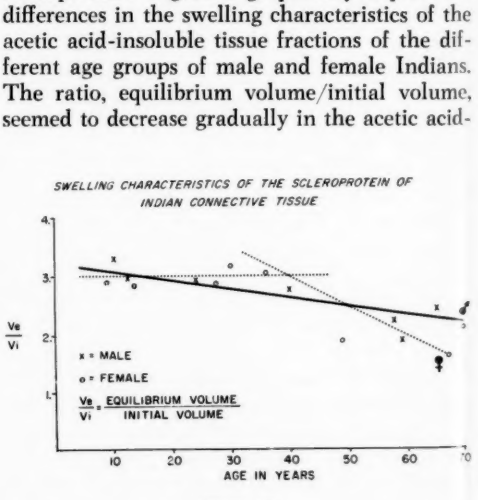

Figure 2.

insoluble fraction of the male tissue with age. The swelling of the tissues obtained from the young and middle-aged female Indians was constant. The older groups (49 to 70 years) of Indian females had swelling properties similar to the older group (58 to 65 years) of male Indians, i.e., a decreased tendency to swell.

The effects of ethnic derivations upon the acetic acid-insoluble fraction.—The concentrations of total protein of the acetic acid-insoluble fraction obtained from the tissues of the middle-aged male groups (20 to 40 years) were different (table 1). The tissues of the Negro and the white males seemed to contain the highest protein concentrations. No racial differences in the concentration of collagenous and non-collagenous protein of the acetic acid-insoluble fraction of the middle-aged males were observed.

DISCUSSION

Connective tissue is made up of ground substance, fibrous protein, and cellular elements, i.e., fibroblasts, histocytes, and mast cells. Some fibrous proteins are extremely rich in hydroxyproline while others, such as elastic fibers, contain far less of the pyrrolidine amino acid. Various aspects of connective tissue are altered by aging. Fibroblasts become more spindle-shaped, mast cells decrease in number and the ground substance to fiber relationship has been reported to change (19) in aging connective tissue.

The human connective tissue studied in the present investigation is different from the connective tissue in which aging changes have been previously reported in that the tissues studied here were all of the same age, i.e., 120 to 190 days, but were developed in human volunteers of different age, sex, and ethnic derivation. In many respects the situation is analogous to the development of new connective tissues in the vascular tree as the result of aging or trauma.

The acetic acid-soluble proteins of human scleroprotein behave as discrete units when examined electrophoretically and by ultracentrifugation. These properties of the acetic acid-soluble fraction of the tissue are similar to those reported by Gross (9) for an acetic acid extract of calf corium. The electrophoretic study indicated that a carbohydrate and a lipid moiety were chemically associated with the protein. The application of the large gravitational force of ultracentrifugation failed to disrupt the monodispersity of the fraction. The assumption that all of the acetic acid-soluble hydroxyproline is present in a collagen containing 13.4 per cent hydroxyproline indicates that a non-collagenous protein is also present in this tissue fraction.

A comparison of the physical chemical characteristics of the acetic acid-soluble protein of the several groups of humans revealed sex and age differences. The intrinsic viscosity, which is an index of the volume per unit mass, was 0.5 for the young group of Eskimo males and increased to 2.7 in the middle-aged and to 4.7 in the older group. These values are lower than those of 13.5 and 16.5 reported by M'Ewen and Pratt for reconstituted collagen (15). However, the intrinsic viscosity of an acetic acid-extract of reconstituted collagen obtained from the acetic acid-soluble tissue fractions of the young and middle-aged male Eskimo was 13.0. The intrinsic viscosity of the acetic acid-soluble protein of female Eskimo connective tissue from the 3 age groups was found to be constant. The changes in the intrinsic viscosities with age in the male Eskimos and Indians are probably related to an alteration in the symmetry of the molecules in solution with an increase in intrinsic viscosity indicating greater asymmetry. This change in symmetry of the acetic acid-soluble molecules was quantitated by the calculation of the axial ratios (J), which increased with age in the male Eskimos and Indians (table 2).

There seemed to be sex and age differences in the molecular weights of the acetic acid-soluble material, which were calculated from the intrinsic viscosity and the sedimentation coefficient. Bowes and Kenten (6) calculated the minimum molecular weight of collagen from their amino acid data to be 39,000. Bear (1) has estimated the molecular weight of collagen from x-ray diffraction and electron microscopy studies to be 63,000 to 65,000. The acetic acid-solubilized fragment of the scleroprotein from young male Eskimo connective tissue had a molecular weight of 96,000, which increased with age of the Eskimo in a manner suggesting linear addition of a repeating unit, i.e., 96,000—221,000—427,000. The molecular weight of the acetic acid-solubilized fragment of the scleroprotein from the female Eskimo tissue decreased with age. The molecular weight of the solubilized material of the old (60 to 65 years) female Eskimo tissue was about one-half that of the old male Eskimo.

The reactions of collagen to weak solutions of acetic acid have been investigated for many years. The effect of acetic acid upon the scleroprotein of connective tissue according to Gustavson (10) is due to a combination of osmotic and lyotropic actions. The lyotropic action, which probably predominates, causes an increase in the width of collagen fibers and lessens the cohesiveness of the individual fibrils. The hydroxyproline content of collagen lends stability to the fibril by interchain hydrogen bonding (11) and it is at these sites of hydrogen bonding that acetic acid seems to exert its greatest effect (13).

Consequently, it would be anticipated that with a greater hydroxyproline content of the scleroprotein there would be a smaller amount of extractable collagen and less swelling. This seemed to be true for the tissue of the male Indian in which 21.5 per cent of the total collagen was solubilized in the young while only 10.0 per cent was solubilized in the old. The swelling of the scleroprotein of the male Indian also decreased with increasing age.

The concept of a direct relationship between internal stability and hydroxyproline concentration does not explain the data obtained from the tissue of the female Indian. The total concentration of hydroxyproline remained constant within the age groups, yet the swelling of the scleroprotein fraction of the female Indian seemed to decrease with age. Consequently, in the old female Indian the increased stability and resistance to swelling might be explained by a cross-linking other than that contributed by hydroxyproline. Such cross-linking may be influenced in part by hormones as suggested by the sharp reduction in scleroprotein swelling in the old age female Indians.

The composition of the acetic acid-soluble protein is relatively constant within any sex or race group. If there is an increase in total soluble protein, both collagen and non-collagen protein increase so that the percentage composition of the increase in total protein is uniform. The composition of the acetic acid-insoluble tissue fraction does not seem to be as uniform as the acetic acid-soluble material.

In this study, the effects of the age of human donors upon the biochemical and physical chemical properties of connective tissue have been presented. It is apparent that collagen formation is greater in the male than in the female and that with aging there seems to be greater internal stability of collagen. Newly-formed connective tissue in the older males produced a soluble collagen of greater molecular weight and intrinsic viscosity than that found in the younger males. This suggests a higher state of polymerization in the metabolically active "procollagen." Should similar changes in the physical properties of collagen occur in the arterial wall then a reduction in vessel elasticity would result and the injurious effects of the pulsatile blows, blood flow currents and eddies, e.g., intimal injury and connective tissue proliferation (17), would be accentuated. The young connective tissue so produced would be expected to be similar to that developed in the sponge and would bind lipids, particularly cholesterol, with great avidity (4). Thus, an atheroma could be started. The age changes observed in newly-formed collagen of the tissue of the male do not become apparent in the female tissue until after the age of 40. After this time, a greater amount of collagen is produced and an increased stability of the scleroprotein occurs as demonstrated by the reduction in swelling.

SUMMARY

Sponges were implanted for either 120 or 190 days in the subcutaneous area of humans of different ages, sexes, and ethnic groups. The newly-formed connective tissue was analyzed and the following results were obtained:

(1) Age and sex effects: (a) Tissues obtained from male donors contained more collagen than those from the female. Old male and female Eskimos produced more collagen than did the younger groups; (b) A smaller percentage of total collagen was solubilized by acetic acid with increasing age in the male; (c) Intrinsic viscosity, molecular weight, and molecular asymmetry seemed to increase with age in the acetic acid-soluble fraction of the tissue of the male. Age of the female donors did not affect the intrinsic viscosity of this soluble fraction but the molecular weight was decreased with age; (d) Collagen concentration of the acetic acid-insoluble fraction of the sponge-biopsy increased with the advancing age of the donor; (e) The extent of the swelling of the scleroprotein in acetic acid was reduced with advancing years in the tissue of the male Indians. Swelling of the tissue of the female did not seem to be affected by aging until after age 40.

(2) Race effects: (a) Eskimos developed more collagen than Indians. The Negroes ap-

peared to develop a scleroprotein with a very high percentage of collagen; (b) Molecular weights and intrinsic viscosities of the acetic acid-soluble tissue fractions seemed to be similar in the races studied.

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THE EFFECT OF AGING ON MUCOPOLYSACCHARIDE COMPOSITION OF HUMAN COSTAL CARTILAGE AS MEASURED BY HEXOSAMINE AND URONIC ACID CONTENT

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The effect of aging on the chemical composition of human cartilage was studied in 1943 by Hass (4), who made calculations of chondroitin sulfate contents from measurements of the reducing substances and total sulfate in hydrolysates of washed cartilage. He concluded that half of the reducing substances and all of the sulfate were derived from chondroitin sulfate. Recently Shetlar and Masters (8) investigated the mucopolysaccharides of human cartilage by making estimations of uronic acid, hexosamine, and hexose. The uronic acid was assumed to be found only in chondroitin sulfate, while the hexosamine, found in excess of the amount calculated to be in chondroitin sulfate, was presumed to be a constituent of neutral polysaccharide. Using these assumptions it could be demonstrated that the chondroitin sulfate content decreased with age, while the neutral polysaccharides increased with age until maturity was reached. These conclusions were confirmed in a study comparing the results of the chemical methods with histochemical results (5). Recent advances in the methods of hydrolyzing polysaccharides and subsequent paper chromatography of the hydrolysates make feasible the development of a procedure for the quantitation of individual carbohydrate components of cartilage. The following work was undertaken to develop such a procedure and to further investigate the carbohydrate constituents of cartilage.

METHODS

Fresh human costal cartilage samples were obtained at autopsy from 15 individuals ranging in age from premature to 85 years. The cartilage was freed of extraneous tissue, cut into small chips, dried and ground as previously described (8). Hydrolysis of this material was catalyzed by the hydrogen form of permutit Q, a polystyrene sulfonic acid resin, as prepared by Glegg (3). Fifty mg. of cartilage, 2 Gm. of resin, and 5 ml. of water were placed in 16 × 125 mm. culture tubes with screw caps, using vinylite cap liners, and incubated at 100 C. for 48 hours. After cooling, the mixture was transferred quantitatively to a glass chromatography column (15 mm. inside diameter, 300 mm. in length). The liquid was collected and the resin washed twice with 10 ml. portions of distilled water. These fractions were combined as eluate A. The resin was then eluted with 20 ml. of 0.5N HCl (eluate B). These eluates were evaporated to dryness in vacuo using a Rinco evaporator and diluted by the addition of 0.5 ml. of distilled water. One-tenth ml. aliquots of these solutions were subjected to one dimensional descending paper chromatography using sheets of Whatman No. 4 chromatographic paper 6 by 22½ in. All materials to be chromatographed were applied as spots along a line of origin 2¾ in. from one of the narrow edges of the paper. The chromatograms were developed at room temperature using the butanol-pyridene-water system of Chargaff and associates (1). Eluate A aliquots, which were found to contain uronic acid, uronic acid lactone, and neutral sugars, were applied 1 in. apart with a standard marker containing 50γ uronic acid spotted in the center position. A complete separation of uronic acid and its lactone from the hexoses and methyl pentose was achieved after chromatography for 16 hrs. The chromatograms were air dried in a fume hood until the pyridene odor was negligible, then in an oven at 110 C. for 2-3 min. to remove the last traces of the solvent system, following which the carbohydrate components were detected by spraying the chromatogram lightly with 2-aminobiphenyl phosphate (9) in glacial acetic acid and heating at 110 C. for 2 to 3 min.

Quantitation of the uronic acid and lactone was made by cutting out the stained uronic acid areas with scissors, reducing these areas to small pieces and transferring them to a glass stop-

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pared 16 × 150 mm. test tube. A paper blank was prepared in the same manner, using a sugar-free area of comparable size from the same sheet of paper. One ml. of distilled water was added to each tube; the tubes were then placed in a boiling water bath for 1 hour. After cooling, 5 ml. of 0.4 per cent 2-aminobiphenyl in glacial acetic acid was added and the samples returned to the boiling water bath for an additional hour. The tubes were then cooled in an ice bath and the contents read in the Beckman DU spectrophotometer at 369 mμ against the paper blank and compared to the uronic acid standard obtained from the same chromatogram.

Eluate B, which was found to contain the hexosamine, was subjected to paper chromatography, using markers composed of a mixture of a known amount of glucosamine (Eastman Kodak) and galactosamine (prepared from chondroitin sulfate) applied along the line of origin 1 in. from each edge of the paper. Duplicate samples of the eluate were applied at points 2¼ in. from the edges. To achieve complete resolution of glucosamine and galactosamine the technique of double development was employed. After the first 16-hr. development the chromatogram was dried and redeveloped in the same direction for an additional 16-hr. period. Quantitation of the hexosamine was carried out by cutting off and staining the side markers and cutting the areas of comparable migration from the two unstained center sections of the paper. These pieces of paper containing the isolated amino sugars were placed in 15 ml. graduated centrifuge tubes and analyzed by a modified Elson-Morgan reaction. To each tube was added 3.5 ml. of distilled water and 2 ml. of freshly prepared acetyl-acetone solution (2% acetyl-acetone dissolved in 0.5 M sodium carbonate). The tubes were stoppered, mixed and placed in a boiling water bath for 20 min., cooled 5-10 min. in an ice bath and diluted to 10 ml. with absolute ethanol. Two ml. of Ehrlichs reagent (prepared by dissolving 5 Gm. p-dimethyl amino benzaldehyde in 190 ml. of absolute ethanol and adding 190 ml. concentrated hydrochloric acid) was added to each tube, mixed carefully, and placed in a 37.5 C. incubator for 45 min. Samples were read against the paper blank at 540 mμ in the Coleman 14 spectrophotometer. The concentrations of glucosamine and galactosamine were calculated on a percentage basis and equated to the total hexosamine value as obtained from previous analysis of a hydrolysate of the dried cartilage.

TABLE 1. SUMMARY OF URONIC ACID AND HEXOSAMINE ANALYSIS OF CARTILAGE FROM INDIVIDUALS OF DIFFERENT AGES.

	Uronic Acid		Hexosamine		
Age	Carbazole	Paper*	Total	Galactosamine†	Glucosamine†
Premature	73.2	72.4	77.0	72.6	4.4
Premature	64.9	63.3	72.0	68.9	3.1
Term	79.5	80.3	84.5	76.7	7.8
1 yr.	53.4	51.2	63.9	52.6	11.3
2 yr.	52.4	62.1	60.5	54.2	6.3
14	31.7	34.5	47.7	30.9	16.8
24	39.1	41.6	71.4	39.9	31.5
31	29.2	32.5	66.6	28.5	38.1
32	35.0	35.5	77.0	27.6	49.4
47	18.5	22.8	57.4	26.8	30.6
60	21.8	20.8	58.4	29.4	29.0
61	16.5	17.1	59.5	15.9	43.6
67	15.0	17.5	52.4	11.4	41.0
79	15.8	16.5	59.6	10.1	49.5
85	8.4	12.5	36.9	6.5	30.4

* Determined by reaction with 2-aminobiphenyl reagent after elution from paper chromatogram.

† Determined after elution from paper chromatogram.

All values are expressed as micrograms per milligram of dry cartilage.

RESULTS

The results of the analysis of individual cartilage samples are listed in table 1 and graphically illustrated in figures 1 and 2. The values obtained by analyses of uronic acid by the carbazole method compare favorably with results from the analyses utilizing paper chro-

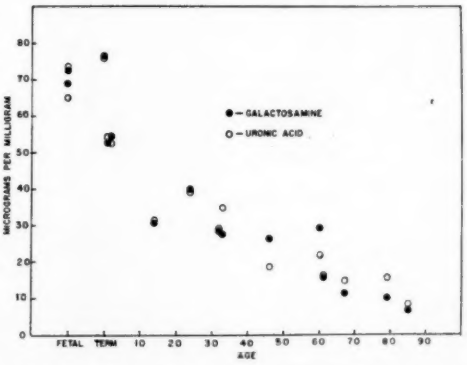

Fig. 1. Changes of the galactosamine and uronic acid of costal cartilage with age. Both galactosamine and uronic acid were determined after separation and elution from paper chromatograms.

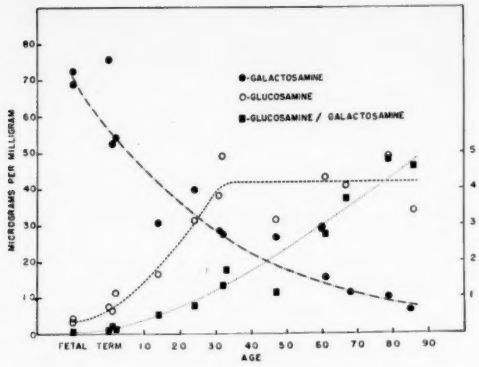

Fig. 2. Changes of galactosamine and glucosamine with age. Both hexosamines were determined after separation and elution from paper chromatograms.

matography followed by quantitation with the aminobiphenyl reagent (table 1). It can readily be seen that uronic acid values decrease with the aging process as do those of galactosamine and that these substances apparently occur in equimolar ratios (fig. 1). Glucosamine levels were found to increase until maturity after which there was no appreciable change.

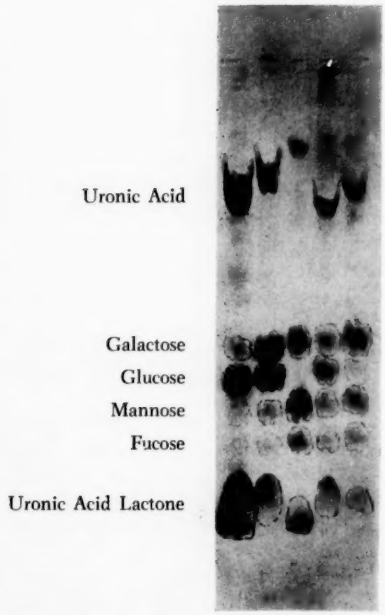

Fig. 3. Paper chromatogram of eluates A of hydrolyzed human cartilage. Individuals range in age from left to right: premature, 14, 47, and 85 years. A marker of standard reference sugars is in the center position.

Figures 3 and 4 are paper chromatograms of cartilage hydrolysates of eluates A and B respectively, of various age samples. Eluate A (fig. 3) contains uronic acid, uronic acid lactone, galactose, mannose, glucose, and fucose while eluate B (fig. 4) contains galactosamine and glucosamine. These figures confirm, by visual comparison, the changes noted in the carbohydrate constitutents of cartilage as determined by chemical analyses, that is, comparativly higher uronic acid and galactosamine levels in young cartilage.

DISCUSSION

The method described for the isolation and quantitation of the hexosamines and uronic acid of the mucopolysaccharides of human cartilage agrees well with the available chemical methods for the analysis of the carbohydrates of cartilage. The use of this method confirms the previous studies of Shetlar and Masters (8) and Joel and associates (5) with respect to the change in chondroitin sulfate with age. The glucosamine as identified by paper chromatography seems equivalent to the "hexosamine in excess of that bound to uronic acid" previously reported by Shetlar and Masters (8). The presence of glucosamine as well as the occur-

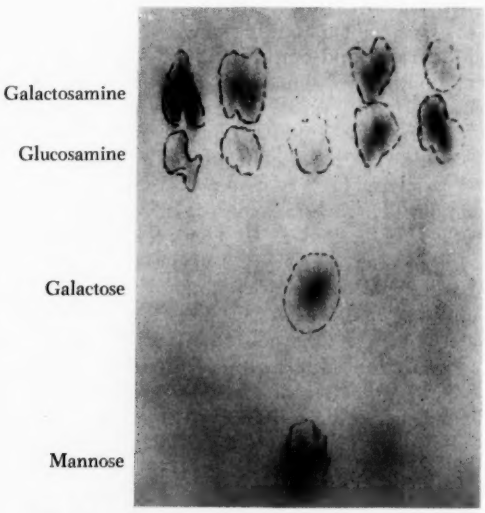

Fig. 4. Section of a paper chromatogram of eluates B of hydrolyzed human cartilage. Individuals range in age, from left to right: premature, 14, 47, and 85 years. A marker of standard reference sugars is in the center position. Note the relatively strong galactosamine spot in the premature sample.

rence of galactose, mannose, and fucose in the hydrolysates indicates that neutral mucopolysaccharide is present in human cartilage. The presence of galactose, mannose, and fucose leads to the suggestion that more than one neutral polysaccharide may be present. Meyer and associates (6) have isolated from cornea a sulfomucopolysaccharide which they have named keratosulfate, while Meyer (7) has reported the occurrence of a similar component in calf bone. This compound is composed of N-acetyl glucosamine, galactose, and sulfate in equimolar ratios. While acetate and sulfate were not determined in this study, it is possible that keratosulfate is also present in human cartilage, since galactose is a major hexose component. The presence of glucose in the cartilage hydrolysate may be assumed to be due to glycogen.

Dyrbye and Kirk (2) recently reported a study involving the isolation of mucopolysaccharides from human arterial tissue by a procedure which should yield largely acid polysaccharide material. The yield from aortas of older subjects was decidely lower than that from aortas of either children or young adults. In a general way these results tend to indicate a similar aging pattern for the acid mucopolysaccharides of both costal cartilage and arterial wall tissue. The need of a wide study of connective tissue from a number of different sources as affected by age is indicated.

SUMMARY

Hydrolysates of human costal cartilage obtained from 15 individuals ranging in age from premature to 85 years were assayed for glucosamine, galactosamine, and uronic acid, using the methods of hydrolysis by a sulfonic acid resin, isolation by paper chromatography, and subsequent quantitation by colorimetric means. It was found that the chondroitin sulfate content, as reflected by galactosamine or uronic acid estimations, decreased with increasing age, while glucosamine content increased until maturity after which no significant change was observed. The presence of mannose, galactose, and fucose, as well as glucose, was noted in the hydrolysates of human cartilage.

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HISTOLOGIC AND HISTOCHEMICAL STUDIES ON THE PERIOSTEUM OF MALE AND FEMALE RATS AT DIFFERENT AGES*

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The periosteum may be considered as consisting of two layers, an outer fibrous layer made up of collagenous fibers and fibroblasts and an inner osteogenic layer of undifferentiated osteogenic cells and osteoblasts. The inner layer is very cellular in bones during active growth (12). With increasing age the osteogenic layer contains fewer cells; osteoblasts are almost entirely absent, leaving only occasional non-differentiated osteogenic cells. These, however, do not lose their ability to proliferate and differentiate when the need arises, even in old age (e.g., bone trauma), but repair then proceeds at a reduced rate.

It was the aim of this investigation to study some of the biochemical processes taking place in the periosteum and possibly involved in bone growth, development, and repair.

MATERIALS AND METHODS

Rats of a Long-Evans strain were segregated into 5 age groups. Each group was made up of 10 males and 10 females. Group I consisted of 1-week-old rats, Group II of 5-week-old, Group III of 8-week-old, Group IV of 26-week-old, and Group V of rats ranging between the ages of 65 to 104 weeks.

Animals were sacrificed by etherization. Immediately after death, three 3 mm. cross sections of one leg were made in the midfemoral region. The tissues were placed in 80 per cent alcohol, acetone, or 10 per cent formalin, respectively. Two 3 mm. cross sections were made of the opposite leg in the corresponding region. Respiratory enzymes were studied in frozen sections.

The fixed tissues were embedded in paraffin, and the tissues were sectioned at 5 μ.

Tissues from Groups I and II could be sectioned without decalcification. Bone fragments in the tissues of Groups III, IV, and V were removed by scraping with a scalpel. The periosteum was thus left intact.

Harris hematoxylin and eosin stain was used for histologic studies. The revised method of Gomori (10) and a modification of the coupling azo dye method of Friedman and Seligman (8) were used for alkaline phosphatase. The former involved a 2-hour incubation in sodium β-glycerophosphate substrate at 37 C. One-hour incubation at room temperature with a stable diazotate of 4-benzoyl-amino-2:5-dimethoxyaniline* added to sodium α-naphthyl phosphate substrate was employed for the azo dye method.

The modified coupling azo dye technique of Grogg and Pearse (11) was used for the demonstration of acid phosphatase. Sections were incubated in a substrate composed of a stable diazotate of o-dianisidine* and sodium α-naphthyl phosphate in a refrigerator at 6 C. overnight. The G-Nadi reaction as suggested by Moog (20) was used for visualization of cytochrome oxidase. The method of Straus, Cheronis, and Straus (29) was employed for localization of succinic dehydrogenase utilizing 2, 3, 5-triphenyltetrazolium chloride.*

The quantitation of results was based on a visual inspection of the intensity of the precipitate or staining reaction, which was compared to that found in the sections of animals of Group I.

RESULTS

Histologic studies.—The periosteum of Group I rats consisted of several layers. The inner (osteogenic) layer was made up almost entirely of mesenchymal cells having round to oval nuclei. The cells were arranged loosely with clear and abundant intercellular space present. The nuclei of these cells were somewhat larger and the cytoplasm more abundant than those of the cells of the outer (fibrous) layer. The largest cells adjacent to the ossify-

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* Obtained from Dajac Laboratories, Leominster, Massachusetts.

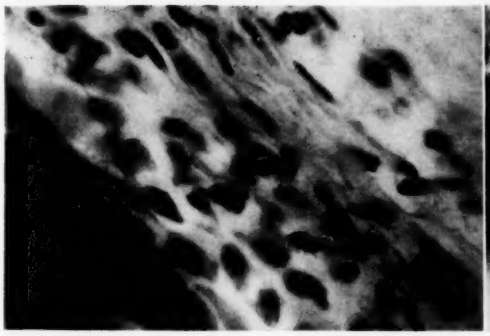

Fig. 1. A section of the periosteum from the femur of a new-born rat revealing a clear division into fibrous and osteogenic layers. The polarized fibrous layer, running diagonally to the lower right side of the photomicrograph, is made up of spindle-shaped cells with elongated nuclei. The highly cellular, osteogenic layer adjacent to the deep eosinophilic staining mass of undecalcified bone contains numerous osteoblasts. Hematoxylin and eosin. X 920.

Fig. 2. A section of the periosteum from the femur of a 104-weeks-old rat exhibiting poor demarcation between osteogenic and fibrous layers due to an abundance of fibrous matrix. The periosteal cells are far apart and their nuclei show various degrees of pyknosis. The dark staining mass at the bottom right corner of the photomicrograph is bone. Hematoxylin and eosin. X 920.

ing region of the bone seemed to be osteoblasts. The fibrous layer was made up of spindle-shaped cells with elongated nuclei and a fibrous matrix running parallel to the osteogenic layer (fig. 1). In successively older groups the osteogenic layer changed from an undifferentiated mesenchymal type to a spindle type, which gave rise to fibrillar elements in the intercellular spaces. The fibrillar layer reached twice the width of the osteogenic layer. The cellular structures became increasingly separated by fibrillar elements. With increasing age the osteogenic layer also contained more fibrillar tissue.

The fibers of the osteogenic layer of Group III rats seemed to be polarized toward the bony shaft. However, as the animals became older, this polarization was gradually lost. Only a few osteoblasts were noted at about the age of 6 months. The periosteum of Group V seemed devoid of osteoblasts and was made up of a compact fibrous matrix with cells far apart. Most of the nuclei were pyknotic (fig. 2).

Alkaline phosphatase studies.—There was a marked difference between fibrous and osteogenic layers. The former was faintly positive in all groups except for some nuclei close to the area of intense activity within the osteogenic layer. The cells of the latter were intensely positive so that, in many instances, it was impossible to distinguish the nucleus from the cytoplasm or matrix. Although in Group I rats the tissues were strongly positive for alkaline phosphatase, the corresponding areas of animals of Group II revealed a still more intense activity. The tissues of Group III rats showed a sharp decline in the over-all alkaline phosphatase activity, while in Group IV there was again an increase to about the level of activity of Group I. The enzyme activity of Group V animals remained intense, although the osteogenic layer was narrowed. Similar results were obtained by both the Gomori and the Friedman and Seligman techniques. There were no sex differences in the activity or distribution of enzyme.

Acid phosphatase studies.—The osteogenic layer of Group I rats was strongly positive for acid phosphatase activity, while the fibrous layer was generally negative. Some increase in acid phosphatase activity was noted in the osteogenic layer of Group II rats. Sections from Group III revealed a drop in enzyme activity and again a rise in activity in Group IV to about that of Group I. Group V sections showed the activity seen in Group IV. No sex difference was noted in acid phosphatase activity.

Cytochrome oxidase studies.—Cytochrome oxidase activity throughout the periosteum, particularly in the osteogenic layer, was demonstrated in sections of rats of Group I. The cellular cytoplasm contained blue, granular particles, indicating the presence of cytochrome oxidase. Group II animals revealed an increase in enzyme activity, particularly in the osteo-

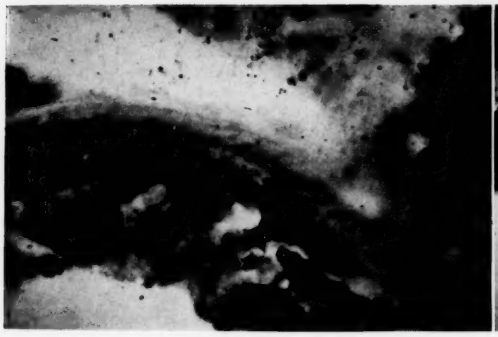

Fig. 3. A cross section of the mid-femoral region of the leg of a 5-weeks-old rat exhibiting cytochrome oxidase activity. The periosteum lies across the center of the photomicrograph. The osteogenic layer (above and adjacent to the strongly positive bone elements) seems to have greater enzyme activity than the slightly positive fibrous layer which is hardly noticeable above the osteogenic layer. A bundle of intensely positive muscle fibers is seen at the upper right hand corner. Lipid droplets which stain deeply are scattered through the surface of the frozen section. Moog method. X 100.

Fig. 4. A cross section of the mid-fermoral region of the leg of an 8-weeks-old rat. The frozen section of the periosteum running across the middle of the photomicrograph reveals no distinction between osteogenic and fibrous layers as a result of cytochrome oxidase activity which is quite low and irregular at this age. The scattered dark bodies are lipid droplets which stain deeply with the Nadi reagent. Strongly staining muscle bundles are seen at the upper part of the photomicrograph. Moog method. X 100.

blasts in the region adjacent to the bone (fig. 3). Group III revealed only traces of activity and older groups none at all (fig. 4). Only rarely and in small areas near the bone were there occasional cells positive for cytochrome oxidase. These cells were morphologically fibroblasts rather than osteoblasts. No sex differences in cytochrome oxidase activity were noted.

Succinic dehydrogenase studies.—Animals of Group I revealed a positive succinic dehydrogenase reaction. Cells of the osteogenic layer disclosed the most marked activity, which increased toward the shaft. Positive reactions ranged from a diffuse light pink tint in the cytoplasm to a pink cytoplasm containing small reddish granules near the bone; the latter became larger, finally giving way to groups of tiny dark red formazan crystals. The cells closest to the bone contained large dark purple crystals within a clear cytoplasm. Cells of the fibrous layer exhibited a few fine reddish cytoplasmic granules and a pink cytoplasm. The osteogenic layer of Group II animals revealed an increased succinic dehydrogenase activity (fig. 5). The majority of the cells contained large dark red crystals in a clear cytoplasm. The reaction was the most intense in cells adjacent to ossifying areas. The fibrous layer was sharply distinguished from the osteogenic layer by its comparatively negative reaction. Group III sections revealed a sharp drop in enzyme activity which was much lower than that of Group I; a diffuse pink was noted in the cytoplasm of the osteogenic cells. Only ocasionally were fine reddish granules observed in Group III (fig. 6). The periosteum of Groups IV and V animals was generally negative for succinic dehydrogenase. Occasionally small areas of a diffuse, faint pink were noted in the osteogenic layer. No sex differences in succinic dehydrogenase activity were detected.

Figure 7 reveals the distribution of respiratory enzyme activity in the osteogenic layer of the periosteum.

DISCUSSION

Large quantities of alkaline phosphatase have been found in the osteogenic layer of the periosteum of growing rats. Increased enzyme activity was noted during the period of active bone formation. This finding parallels the results of previous investigators (1, 5, 6 ,7). However, even in older animals, an intense reaction was still present. Decreased ossification occurring after an intense period of bone formation in young animals is therefore not caused by reduced alkaline phosphatase activity.

The critical drop in alkaline phosphatase found in the periosteum at the age of 2 months may be caused by the increased output of sex hormones at this period of life. Silberberg and Silberberg (26, 27, 28) as well as other in-

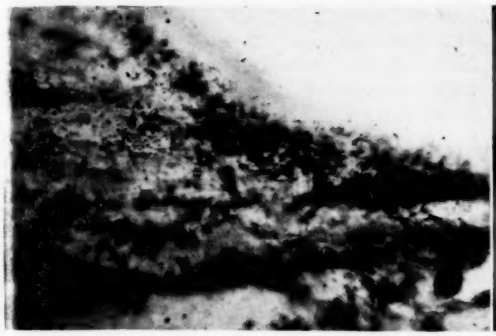

Fig. 5. A section of a 5-weeks-old rat femur revealing the presence of large quantities of formazan crystals indicative of succinic dehydrogenase activity in the osteogenic layer of the periosteum. The fibrous layer can barely be seen and seems negative. The crystals seen in the bone, at the lower left half of the photomicrograph, are localized in the cytoplasm of osteocytes. Straus, Cheronis, and Straus method. X 100.

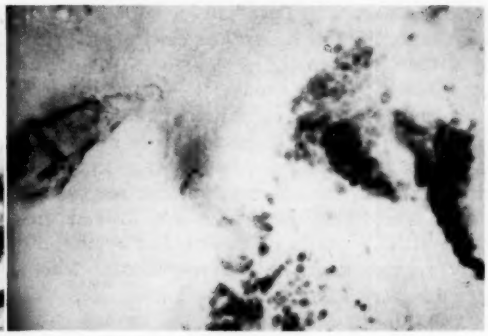

Fig. 6. Cross section of the periosteum from the mid-femoral region of the leg of a 8-weeks-old rat exhibiting only a faint succinic dehydrogenase activity in the osteogenic layer of the periosteum. The osteogenic layer is to the left of the numerous, round, deeply staining lipid bodies. The fibrous layer at the upper left of the osteogenic layer is barely visible. A fragment of cortical bone is seen at the far left of the photomicrograph. Straus, Cheronis, and Straus method. X 100.

vestigators (2, 9, 16, 30) showed that in mice, rats, and other species estrogen and testosterone produced similar effects upon the growing skeleton. The temporary drop in phosphatase activity at 8 weeks of age does not seem to be caused by local factors which might be characteristic of the mid-shaft since this was also observed in the periosteum near the metaphysis and epiphysis, but is probably comparable to the temporary period of inhibition of bone resorption after administration of estrogen and testosterone.

The finding of large quantities of acid phosphatase in the osteogenic layer at all ages but with a maximum appearing at the period of intense bone formation suggests that the role of alkaline phosphataste in bone formation may be shared by acid phosphatase. The presence of both phosphatases may indicate the existence of a safety mechanism for: 1) the utilization of different substrates which may be available or produced at different times, and 2) the continuity of bone formation irrespective of local pH changes or of those brought about by increasing age. Follis (6) suggested that many substrates might be utilized by the periosteum and that some of these are best utilized at other than an alkaline pH.

Follis and Berthrong (7) reported that the periosteum of rats, guinea pigs, and humans exhibited a bluish haze when studied for cytochrome oxidase. The findings of the present investigation revealed a definite pattern for cytochrome oxidase. The activity of this enzyme reached a maximum during the period of maximum bone formation, that is, in Group II animals; in animals only 3 to 4 weeks older, the enzyme activity dropped drastically and remained at this low level in the older groups.

The pattern for succinic dehydrogenase was similar to but better defined than that of cytochrome oxidase. The sharp drop in the respiratory enzymes could not be attributed to the decreased number of osteoblasts since many

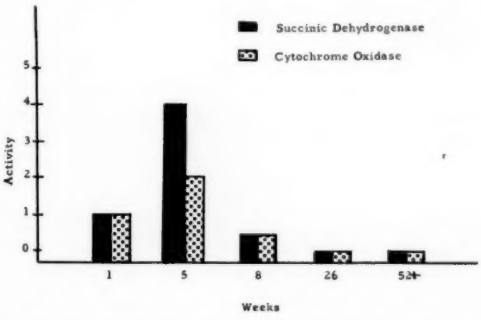

Fig. 7. Comparison between the distribution of cytochrome oxidase and succinic dehydrogenase activity in the osteogenic layer of the mid-femoral region of the periosteum of rats of different ages. The respiratory enzyme activity is based on the visual inspection of the sections and comparison of the intensity of the precipitate or color. Note the rise in both respiratory enzyme activities at 5 weeks of age and their subsequent drop which is maintained during the following ages.

other cells were also positive for both enzymes. Moreover, the fall in enzyme activity occurred at a time prior to the drop in the number of osteoblasts. The decrease of respiratory activity, however, may be indirectly related to the retardation of bone formation with increasing age once the maximum has been reached. If this were true, the decrease in the number of osteoblasts would be irrelevant; instead enzyme activity would be determined by the energy requirements of the osteoblasts, whose function varies at different periods of life.

According to Schneider (22, 23, 24) and others (13, 14, 25), essentially all of the succinoxidase and cytochrome oxidase activity is associated with the mitochondria. Variations in respiratory enzymes noted during this investigation then seemed to involve mitochondrial activity during bone formation. Something is happening to mitochondria, either directly or indirectly, during aging which is reflected in the varying activities of the respiratory enzymes. Studies on oxidative phosphorylation by Ernster, Lindberg, and Löw (3), Ernster and Löw (4), and Lindberg (17) have shown that in vitro aged mitochondria reveal a drop in oxidative phosphorylation. Numerous factors are involved in the in vitro aging of mitochondria (3, 15, 17, 18, 19). One may therefore surmise that mitochondrial aging in vivo is also related to reduced oxidative phosphorylating capacity. One or a number of substances may be involved in this mechanism. Pullman and Racker (21) suggested that aging mitochondria release an oxidative phosphorylation inhibitor.

It is not known at the present time what causes this age change. However, chances of such a degradation occurring in cells involved with bone formation and repair are high.

SUMMARY

The histology and the activities of acid and alkaline phosphatase, cytochrome oxidase, and succinic dehydrogenase of the periosteum of rat femora were studied from birth to old age. Histologically and cytologically the layers of the periosteum revealed changing phases from active physiologic and biochemical to less active stages. Both acid and alkaline phosphatase were localized mainly in the osteogenic layer and appeared in abundance throughout the life span of the animals. A rise in activity was noted during maximum bone formation. The respiratory enzymes were most active in the osteogenic layer, particularly in the osteoblasts of the preosseous zone. Maximum activity was observed during the period of maximum bone formation. After 5 weeks of age the respiratory enzyme activity fell drastically and remained at a low level throughout the following ages. The osteoblasts were numerous at 8 weeks of age with only trace activities for respiratory enzymes. No sex differences in enzyme activities were noted.

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AGE DIFFERENCES IN CHOLINESTERASE ACTIVITY OF SERUM AND LIVER

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This study was undertaken to establish whether alterations in enzymic activities of the blood occur with advancing age. The enzyme cholinesterase was chosen for study because it can be determined with a high degree of precision in small samples of serum, which makes it possible to study both humans and rats. Since cholinesterase is synthesized in the liver (6, 8, 9, 12), determinations of this enzymic activity were made in this tissue taken from old and young rats.

EXPERIMENTAL METHODS

Human Subjects. Fasting venous blood samples were drawn from 128 males, age 20 to 90 years, selected from the Gerontology Branch and Infirmary Division of the Baltimore City Hospital, and male staff members of the Gerontology Branch and the Johns Hopkins School of Hygiene and Public Health. All subjects were ambulatory and free from overt disease. After clotting, serum was separated, quickly frozen, and stored in a freezer at −25 F. until analyzed.

Animals. Sixty rats (20 male and 40 female) of the McCollum strain were bred in the laboratory and maintained, 5 in a cage on wood shavings in air-conditioned quarters (75 ± 2 F.) throughout their life span. A standard stock diet (3) was fed *ad libitum*. All animals were unmated. Determinations of cholinesterase activity of serum and liver were made in 40 females and of serum in 20 males, aged 12-14 months and 24-27 months. The rats were stunned by a blow on the back of the neck and bled by cardiac puncture. Serum obtained was quickly frozen and stored at −25 F. until analyzed. The liver was immediately removed, homogenized in 0.045 M $NaHCO_3$, and analyzed.

Determination of Cholinesterase. The cholinesterase activity of sera and liver homogenates was determined by the method of Ammon (1) as modified by Mazur and Bodansky (11).

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RESULTS

Reliability of Chemical Determination. The mean difference between duplicate determinations carried out on 50 sera samples was 0.56 mm^3 CO_2/0.1 cm^3/hr. The standard deviation of the distribution of the difference, between duplicate analyses, was 16.8 mm^3 CO_2/0.1 cm^3/hr.

Effect of Storage. In order to determine the stability of cholinesterase during storage at −25 F., the enzymic activity of sera obtained from 10 rats was determined immediately and following one month of storage. The mean difference between the activity of the fresh and frozen samples was −2.8 mm^3 CO_2/0.1 cm^3/hr. ($\sigma_{mn.\ diff.} = 2.0$, $t = 1.4$). Thus there is no systematic change in the cholinesterase activity of sera when stored under these conditions.

Individual Variability. In the 10 individuals whose serum cholinesterase was determined on different days no significant difference was established between the first and the second tests. The time between the tests varied from 32 to 65 days. These results (table 1) indicate that within the limits of measurement this enzyme is a stable characteristic of an individual over a short period of time.

Age Differences in Serum Levels: Human Males. The cholinesterase content of the serum of human males showed a significant negative correlation with age ($r = -0.39$; $p<0.001$). The regression equation was:

Serum cholinesterase (mm^3 CO_2/0.1 cm^3/hr.) $= 588 - 2.33 \times$ age (yrs.)

The standard error of the regression coefficient (-2.33) was 0.487.

Age Differences in Serum Levels: Rats. The serum cholinesterase of female rats was determined in two different experiments. In each experiment the average concentration of the enzyme of ten 24-27-month-old rats was significantly less than that of ten 12-14-month-old animals (table 2).

No age difference in the serum cholinesterase of male animals could be found (table 2). The

TABLE 1. DAY-TO-DAY VARIATION IN SERUM CHOLINESTERASE ACTIVITY.

Subject	Cholinesterase Activity (mm^3 CO_2/0.1 cm^3/hr.)			
	Interval Between Tests (Days)	Day 1	Day 2	Difference (Day 2—Day 1)
RW	41	516	524	+ 8
JD	32	440	402	−38
AD	62	390	428	+38
EH	59	410	418	+ 8
EK	40	382	372	−10
JH	65	436	464	+28
DR	51	280	248	−32
TB	51	374	350	−24
EW	51	352	380	+28
OW	51	376	334	−42

Mean diff. = −3.6
σ mean diff. = 9.53
t = 0.38

TABLE 2. AGE DIFFERENCES IN CHOLINESTERASE ACTIVITY OF SERUM IN THE RAT.

	Cholinesterase Activity (mm^3 CO_2/0.1 cm^3/hr.)					
	Females				Males	
	Experiment I		Experiment II		Experiment III	
	N	Mn. ± σmn.	N	Mn. ± σmn.	N	Mn. ± σmn.
Young	10	303 ± 5.7	10	289 ± 10.0	10	89 ± 7.4
Old	10	198 ± 25.1	10	201 ± 12.8	10	87 ± 5.3
Difference		105		88		2
p		<.001		<.001		NS

TABLE 3. THE CHOLINESTERASE ACTIVITY OF 50% MIXTURES OF SERUM OBTAINED FROM YOUNG AND OLD FEMALE RATS.

Cholinesterase Activity (mm^3 CO_2/0.1 cm^3/hr.)

Observed in Old Rats	Observed in Young Rats	Observed in 50% Mixture	Calculated in 50% Mixture	Difference Observed—Calculated
196	335	262	266	− 4
188	338	275	263	+12
177	362	287	270	+17
107	270	194	189	+ 5
84	193	144	139	+ 5
106	200	153	153	0
106	215	156	161	− 5
37	167	101	102	− 1

Mean diff. = +3.6
σ mean diff. = 2.78
t = 1.3

cholinesterase activities of mixtures of sera of young and old rats were determined. The results (table 3) demonstrate that the experimentally determined activities of the various mixtures were equal, within experimental error, to the sum of the activities of each serum sample. Thus, no evidence is available to indicate a loss of activators or an accumulation of inhibitors in the serum of old rats. No cholinesterase activity was found in the urine of old female rats or of men over 70 years of age. Therefore, it seems unlikely that the agewise decrement in the concentration of serum cholinesterase may be attributed to urinary loss.

Cholinesterase Activity of Female Rat Liver. Since cholinesterase is synthesized in the liver (6, 8, 9, 12), the effect of age on the concentration of this enzyme in liver tissue of young (12-14 months) and old (24-27 months) female rats was determined in two different experiments. The mean values and the standard error of the mean for the young and old rats were 581 ± 28.2 and 494 ± 45.7, respectively, in the first experiment and 561 ± 30.3 and 573 ± 24.8 in the second. There was no significant age difference in the cholinesterase of liver tissue of female rats.

DISCUSSION

Evidence has been presented to show that there are measurable individual differences in the cholinesterase activity of the serum. The values obtained in the present study of human subjects are in agreement with those reported in previous studies which have used comparable methods for the analysis of cholinesterase activities (table 4). Previous studies have not given the age distributions of the subjects so that detailed comparisons are impossible. The results of McCardle (12) and Grob (9) combined data for males and females. If the contention that serum levels of cholinesterase are lower in females than in males is true (18), the slightly lower values reported in these studies may be explained.

A number of factors may contribute to the agewise decrease in the cholinesterase activity of serum in human male subjects and in female rats. Among them the following may be mentioned: 1) an increase in inhibitors or a decrease in activators in the serum of aged animals, 2) increased urinary loss of the enzyme in the aged, 3) reduced synthesis of the enzyme by the liver, 4) increased rate of de-

TABLE 4. MEAN SERUM CHOLINESTERASE VALUES OF HEALTHY HUMAN SUBJECTS. (SUMMARY OF DATA FROM THE LITERATURE)

Author	Sex	Age	N	Serum Cholinesterase*	
				mm³ CO_2/0.1 cm³/hr.	σdist.
Present Study	M	30	..	518†	105‡
	M	50	..	471†	105‡
	M	70	..	425†	105‡
	M	90	..	378†	105‡
	total M	30–90	128	453	114
McCardle, B. (12)§	M & F	20–52	40	468	108
Grob, D., Lilienthal, J. L., Jr., Harvey, A. M., and Jones, B. F. (9)	M & F	..	75	414	75
Hutchinson, A. O., McCance, R. A., and Widdowson, E. M. (10)	M	..	37	474	92
Callaway, S., Davies, D. R., and Rutland, J. P. (5)	M	18–30	87	520	102
	M	18–69	76	543	147
	F	18–69	65	530	123
Faber, M. (8)	M	..	26	464	100
	F	..	23	360	118

* Values from the literature recalculated.
† Calculated from regression equation: Serum cholinesterase (mm³ CO_2/0.1 cm³/hr.) = 588 − 2.33 × age (yrs.).
‡ Calulated as $\sigma_{est.}$, based on σ of total distribution over all ages of 113.6.
§ Reference number.

struction of the enzyme in the aged, and 5) influence of sex hormones. A reduction in synthesis might be due either to impairments in the metabolic processes or to inadequacy of dietary intake of essential materials.

The experiments performed on mixtures of sera from old and young rats failed to produce evidence for an accumulation of inhibitors or a loss of activators in the serum of the old rats. Neither was there any evidence of an increased urinary loss of the enzyme in old age.

Since the cholinesterase activity of the liver was the same in old and young rats, it must be assumed that the synthetic capacity of the liver of the old animals is adequate to maintain normal concentrations of the enzyme in the tissue itself. However, it is possible that in the aged animal the synthetic capacity is somewhat reduced, so that less of the enzyme appears in the plasma.

Other studies have shown a reduction in cholinesterase activity of the serum of female rats during starvation, cortisone administration and the feeding of a protein-free or inadequate protein diet (2). Hutchinson, McCance and Widdowson (10) have also reported a reduction in serum cholinesterase activity in undernourished men which was restored with adequate diet. Since the changes in serum cholinesterase have been greater under these conditions than the attendant changes in body weight or total plasma proteins, it has been suggested that the cholinesterase level of the serum is a sensitive index of protein metabolism. On this basis it might be assumed that increasing age is associated with an impaired protein metabolism. However, the present state of our knowledge does not permit this inference.

The average values of serum cholinesterase are lower in women than in men, although the statistical significance of the difference is questionable in some of the studies. However, in this investigation, as well as others (4, 6, 15), considerably higher serum cholinesterase activities were observed in mature female as compared to male rats. A significant age difference could be established only in the female animals in the present study. This may be due to the existence of two forms of cholinesterase; viz., true and pseudo cholinesterase.* Although both types of cholinesterase are found in human (10) and rat serum (6), the method used in these studies determined primarily pseudo cholinesterase. Both humans (10) and female rats (6) show a high ratio of pseudo to true cholinesterase in the serum in contrast to the male rat where the ratio is low (15). This reduced ratio and the inability to exclude completely the effect of true cholinesterase activity in the determinations may account for the in-

* Although both forms hydrolyze acetyl choline, they differ in substrate specificity. True cholinesterase exists in the erythrocytes and in nervous tissue. It exhibits maximum activity in the presence of low concentrations of acetyl choline and is capable of hydrolyzing acetyl-β-methylcholine but not benzoylcholine. Pseudo cholinesterase is found in serum, liver and other organs. It exhibits maximum activity in the presence of high concentrations of acetyl choline and hydrolyzes benzoylcholine but not acetyl-β-methylcholine (13, 14).

ability to demonstrate a significant age regression in the male animals.

Other investigators have shown that serum cholinesterase levels are reduced in female rats by castration and can be restored by the administration of estrogens (7, 17). Hence it is possible that the agewise reduction in serum cholinesterase in the female rats may be related to a reduction in the production of estrogens. However, it seems unlikely that the age regression observed in men can be explained on this basis since the urinary excretion of estrogens in men does not vary with age (16).

Although the present study has shown a significant decrement in serum cholinesterase with increasing age in males, additional studies are required to identify the mechanisms involved.

SUMMARY

Serum cholinesterase was determined in 128 men aged 20 to 90 years. A significant decrease in the concentration of the enzyme with age was demonstrated.

Cholinesterase activity was further measured in 40 female and 20 male rats. The enzyme activity was found to be significantly lower in the serum of 24-27-month-old as compared to 12-14-month-old female rats. No difference was observed when the serum of male rats of these ages was examined.

Determination of cholinesterase activity of liver tissue in the female rats failed to demonstrate an age difference.

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THE LACTIC DEHYDROGENASE, MALIC DEHYDROGENASE, AND PHOSPHOGLUCOISOMERASE ACTIVITIES OF CORONARY ARTERY TISSUE IN INDIVIDUALS OF VARIOUS AGES*

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In previous studies from this laboratory (1, 2) the lactic dehydrogenase, malic dehydrogenase, and phosphoglucoisomerase activities of human aortic and pulmonary artery tissue in individuals of various ages were reported. The present investigation was undertaken with the purpose of providing similar data for the human coronary artery. The enzyme measurements were carried out separately on normal tissue of the right and left coronary artery and on arteriosclerotic tissue portions of the left coronary artery.

MATERIAL AND METHODS

Fifty human hearts were obtained fresh at autopsy at the St. Louis City Morgue‡ and were placed in beakers immersed in ice. The age of the individuals from whom the samples were derived ranged between 0.5 and 81 years. The coronary arteries were carefully removed by dissection and 5 per cent aqueous homogenates prepared of macroscopically normal portions of the right and left artery, and of arteriosclerotic areas of the left artery. The 5 per cent homogenates were used for determination of the phosphoglucoisomerase activity; for measurement of the lactic and malic dehydrogenase activities the homogenates were diluted with water to make 2 per cent tissue suspensions which were rehomogenized briefly immediately before use.

The enzyme measurements were carried out as previously described (1, 2). Because of the small quantities of arterial material available determinations of tissue dry weight, nitrogen, and cholesterol were not performed.

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† St. Louis Heart Association Research Fellow.

‡ The authors are indebted to Dr. J. J. Connor for assistance in obtaining specimens.

RESULTS

The mean enzyme activities observed for the various age groups are listed in table 1. The average quantities of substrate metabolized by the right coronary artery were 0.65 mM (lactic dehydrogenase), 0.80 mM (malic dehydrogenase), and 1.72 mM (phosphoglucoisomerase)/Gm. wet tissue/hour. The corresponding values for the normal tissue of the left coronary artery were 0.69, 0.93, and 1.93 mM. The t values for the differences between the means found for the right and left arteries are 0.50 (lactic dehydrogenase), 1.76 (malic dehydrogenase), and 1.72 (phosphoglucoisomerase); for the number of samples included in the present study these differences are not statistically significant.

It will further be seen from table 1 that the mean enzyme activities of the arteriosclerotic sections of the left coronary artery were definitely lower than the values found for the normal tissue of that artery. Thus the average lactic dehydrogenase activity of the arteriosclerotic tissue was 81 per cent, the malic dehydrogenase activity 66 per cent, and the phosphoglucoisomerase activity 76 per cent of the mean values found for the normal tissue.

A calculation of the coefficients of correlation between age and observed enzyme activities failed to reveal any significant change in the activity values with age (table 2).

A comparison of the enzyme activities of the normal coronary artery tissue with the activities found for normal aortic tissue obtained from the same individuals showed that the lactic dehydrogenase activity of the coronary arteries was markedly lower, and the malic dehydrogenase activity considerably higher than the values observed for the aortic tissue (table 3).

TABLE 1. MEAN LACTIC DEHYDROGENASE, MALIC DEHYDROGENASE, AND PHOSPHOGLUCOISOMERASE ACTIVITIES OF CORONARY ARTERY TISSUE IN VARIOUS AGE GROUPS.

Age Group Years	LACTIC DEHYDROGENASE						MALIC DEHYDROGENASE						PHOSPHOGLUCOISOMERASE					
	mM lactic acid metab./ Gm. wet tissue/hour						mM l-malic acid metab./ Gm. wet tissue /hour						mM glucose-6-phosphate metab./ Gm. wet tissue/hour					
	Right Coronary Artery		Left Coronary Artery				Right Coronary Artery		Left Coronary Artery				Right Coronary Artery		Left Coronary Artery			
	Normal		Normal		Arteriosel.		Normal		Normal		Arteriosel.		Normal		Normal		Arteriosel.	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
0– 4	6	0.50	9	0.70			6	0.64	9	0.97			6	1.64	9	1.90		
17–39	9	0.63	10	0.73	4	0.62	9	0.94	10	1.02	4	0.89	10	1.98	9	2.12	3	1.60
42–59	14	0.76	15	0.72	14	0.58	14	0.83	15	0.89	14	0.63	13	1.70	13	1.88	13	1.36
61–81	15	0.63	16	0.64	16	0.54	15	0.74	16	0.89	16	0.52	14	1.71	13	1.88	14	1.54
Grand mean		0.65		0.69		0.56		0.80		0.93		0.61		1.72		1.93		1.46
s.e. of mean		0.06		0.05		0.05		0.04		0.06		0.04		0.09		0.08		0.11

TABLE 2. COEFFICIENTS OF CORRELATION: AGE/ENZYME ACTIVITY.

	r	t
Lactic dehydrogenase, right coronary artery	+0.10	0.64
Lactic dehydrogenase, left coronary artery, normal	−0.02	0.14
Malic dehydrogenase, right coronary artery	−0.05	0.32
Malic dehydrogenase, left coronary artery, normal	−0.10	0.64
Phosphoglucoisomerase, right coronary artery	−0.09	0.58
Phosphogluccisomerase, left coronary artery, normal	−0.09	0.59

TABLE 3. COMPARISON OF MEAN ENZYME ACTIVITIES OF CORONARY ARTERY TISSUE AND AORTIC TISSUE FROM THE SAME INDIVIDUALS.

Values represent millimoles of substrate metabolized/Gm. wet tissue/hour.

	Aorta	Right Coronary	In % of Aorta	t of diff.	Left Coronary	In % of Aorta	t of diff.
Lactic dehydrogenase	0.92	0.65	72	2.12	0.69	75	1.86
Malic dehydrogenase	0.52	0.80	154	5.72	0.93	179	6.30
Phosphoglucoisomerase	1.68	1.72	102	0.34	1.93	115	2.23

DISCUSSION

An interesting observation emerging from the present study is the finding of a difference in enzyme activities of normal coronary artery tissue as compared with the normal aortic tissue. Thus the malic dehydrogenase activity of the coronary artery tissue was found to be higher than the lactic dehydrogenase activity, the ratio: malic dehydrogenase/lactic dehydrogenase being 1.23 for the right coronary artery, and 1.35 for the left coronary artery. This contrasts with the findings made on the aorta, for which tissue a lower activity of malic dehydrogenase than of lactic dehydrogenase has been established. In a previous study (2) the ratio: malic dehydrogenase/lactic dehydrogenase for 86 samples of normal aortic tissue was found to be only 0.52. This value agrees well with the ratio of 0.57 observed for the aortic tissue samples derived from the subjects from whom the coronary artery samples of the present investigation were obtained.

The finding of lower lactic dehydrogenase, malic dehydrogenase, and phosphoglucoisomerase activities of the wet arteriosclerotic tissue of the left coronary artery as compared with the normal tissue of the same artery is similar to the observations previously reported (1, 2) for arteriosclerotic and normal wet aortic tissue. It should be mentioned in this connection that in the investigations on aortic tissue no difference was noted when the enzyme activities were calculated on the basis of the tissue nitrogen content. In the present study on coronary artery tissue such calculations were not possible because of lack of sufficient tissue for nitrogen analyses.

SUMMARY

Determinations were made of the lactic dehydrogenase, malic dehydrogenase, and phosphoglucoisomerase activities of 50 samples of the right and left coronary artery. The mean quantities of substrate metabolized by the right coronary artery were 0.65 mM (LDH), 0.80 mM (MDH), and 1.72 mM (PGI)/Gm. wet tissue/hour. For the left coronary artery the corresponding average values were 0.69, 0.93, and 1.93 mM. No significant change in enzyme activities with age was observed. The enzyme activities of the arteriosclerotic sections of the left coronary artery were found to be lower than the activities of the normal tissue of the same artery.

The investigation revealed a difference between the enzyme activities of normal coronary artery tissue and normal aortic tissue, the malic dehydrogenase activity of the coronary artery being higher than the lactic dehydrogenase activity, whereas for aortic tissue a higher activity of lactic dehydrogenase than of malic dehydrogenase has been found.

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TEETH, BONES, AND AGING OF SYRIAN HAMSTERS*

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In the study of changes with age the Syrian hamster offers as many advantages as the white rat when it is used as the experimental animal. The hamster can be fed a wide variety of human foods; its life span is about 2 years, with an extreme age of 3 years, it is much less subject to chronic diseases of the lungs than the rat and its teeth are more subject to decay than those of the average strain of white rat. Much is known about factors which produce tooth decay in hamsters but nothing is known about the deterioration of bones in relation to age.

Since hamsters tend to go into negative calcium balance when they become old, they must lose inorganic materials from bones. Even the young hamster is less efficient than the white rat in retaining calcium. At all ages the hamster excretes more calcium from its body through the urine than do white rats (4, 5). This indicates a species difference in kidney function and may account in part for evidence of degenerative joint diseases in aging hamsters (8).

The hamster seems to be especially promising in a study to determine whether the early deterioration of teeth indicates the possibility of serious degeneration of bone in old age. Since little is known about dietary factors which contribute to the development of arthritis and since more can be learned about the maintenance of strong bone structure in old age, the hamster deserves more attention in the small animal laboratory.

EXPERIMENTAL

One hundred and fifty Syrian hamsters were used in an exploratory study to determine the effect of diet upon teeth of the young adult and upon the bones in old age. There were 102 females and 48 males. Since there is some evidence of sex differences in the decay of teeth, these hamsters were divided into 6 groups with sexes distributed as evenly as possible (2).

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At the beginning of this study 10 animals, 21 days old, from each group, or a total of 60, were chosen at random, except that each group contained 4 males, to be kept until the end of life for the study of the density of their bones. The other 90 were predestined to be killed for a study of their teeth after they had been fed the test diets for either 100 or 125 days.

Since little is known about diets for long time studies, 2 basic ones were chosen. The first was a dog meal that had been used as a stock diet for rats, hamsters, and dogs at this laboratory for many years (6). The second was a corn diet that had been used for the production and study of caries in the rat and in the hamster (1). Hoppert and associates (3) devised the use of this diet, which consists of corn meal, 60%, powdered whole milk 30%, linseed meal 6%, alfalfa meal 3%, and sodium chloride 1%. Several studies, such as those of Dale, Lazansky, and Keyes (2), indicate that hamsters exhibit marked caries when they are fed diets rich in ground corn for 100 days. The diets listed below were modified for groups of hamsters as follows:

1. Dog meal alone.
2. Dog meal 2 parts by weight and sucrose 1 part by weight.
3. Dog meal 2 parts by weight and sucrose 1 part by weight plus 0.2% sodium oxalate.
4. Corn diet (Hoppert, 3) alone.
5. Corn diet 2 parts by weight and sucrose 1 part by weight.
6. Corn diet 2 parts by weight and sucrose 1 part by weight plus 0.2% sodium oxalate. (200 mg. of sodium oxalate were added to each 100 Gm. of the diet mixed with sucrose).

The sucrose was added to diets 2 and 5 in an attempt to produce inferior teeth without influencing composition of bone, while the oxalate was added to determine if teeth may be protected from caries while the bones become structurally weaker in old age.

Influence of Diet on Growth of Young Hamsters

Throughout this experiment each animal was weighed each week. Table 1 summarizes the average total increase in weight for males and

TABLE 1. AVERAGE INCREASE IN WEIGHT IN 14 WEEKS (GRAMS).

Sex	Dog Meal			Corn Diet		
	Groups			Groups		
	I	II	III	IV	V	VI
F.	87	86	83	114	76	77
M.	74	88	78	97	84	73
F. and M.	82	87	81	108	78	76

for females for a period of 14 weeks. These data were treated by statistical methods for anaylsis of variance and the "F" values appear in table 2.

When the average increases in weight of all hamsters on both rations were compared, no significant differences were found. Although the heaviest hamsters appeared among those receiving the corn diet, additions to this diet produced the smallest gains in body weight, thus bringing down the over-all average. Males and females grew at about the same rate regardless of rations.

Highly significant differences were produced in gains in weight of hamsters when sugar or sugar and oxalate were added to the corn diet. When these same supplements were added to the dog meal ration, the differences in increase in weight were less significant. The effect of added supplements on growth of hamsters was different for each ration.

Females grew heavier than males on either ration and both sexes attained greater weight on the corn diet alone than on the dog meal alone. The effect of additions to the rations differed significantly for males and females. Addition of sugar to the corn diet produced female hamsters only slightly heavier than males on the dog meal alone.

And finally, the three-way interaction, rations vs. additions vs. sex, is not significant. In other words, the average of the means of gains in weight for females on the 2 rations and on each supplemented ration does not significantly differ from the average of the means of gains in weight of males on the same diets.

Evaluation of the Condition of Hamster Teeth

In scoring the teeth each half-jaw (lower right, lower left, upper right, upper left) was examined separately and given a score of 1, 2, or 3. The score 1 indicates that the teeth were in poor condition, 2 in fair condition, and 3 in good condition. The number and extent of carious lesions (cavities and brown discolorations) were considered in establishing the score. The scores for the 4 half-jaws were then added together to give the total for each animal.

This routine was followed in scoring: the lower right half-jaw was scored for each animal, then the lower left, and so on until the same part had been examined for each animal before taking up the next part to be studied. A completely independent scoring was carried out twice for all animals. The results are summarized in table 3. Unfortunately, the teeth

TABLE 2. ANALYSIS OF VARIANCE, "F" VALUES.

Source of Variation	Degrees of Freedom	F Values
Rations	1	1.77
Additions	2	12.02**
Sex	1	2.40
Rations × Additions	2	14.19**
Rations × Sex	1	0.07
Additions × Sex	2	3.29*
Rations × Additions × Sex	2	0.18
Within Subclasses	137	Mean square=323.42
Total	148	

* Significant F values.
** Highly significant F values.

TABLE 3. SCORING OF HAMSTER TEETH.

Group Number	Sex	Number of Hamsters in Group	Diet	Average Score
1	M	6		8.2
1	F	15	Dog meal	9.2
1	M + F	21		8.9
2	M	4		8.6
2	F	14	Dog meal 2, sugar 1	9.4
2	M + F	18		9.2
3	M	7	Dog meal 2, sugar 1,	8.9
3	F	15	plus	9.0
3	M + F	22	sodium oxalate	9.0
4	M	6		6.6
4	F	13	Corn diet	7.2
4	M + F	19		7.0
5	M	5		4.2
5	F	15	Corn diet 2, sugar 1	5.1
5	M + F	20		4.9
6	M	5	Corn diet 2, sugar 1,	4.9
6	F	13	plus	4.6
6	M + F	18	sodium oxalate	4.7

of 22 hamsters that survived into extreme old age were not included in this study.

In evaluating these results a score of 12 (4 × 3) indicates that the teeth were in good condition; a score of 8 (4 × 2) indicates that the teeth were in fair condition; and a score of 4 (4 × 1) indicates that the teeth were in poor condition.

In the first 3 groups the teeth of all hamsters were about the same and have been rated slightly better than fair. The addition of sugar (group 2) or sugar plus sodium oxalate (group 3) to a diet of dog meal (group 1) seems to have had no effect upon the condition of the teeth of these hamsters.

The teeth of the hamsters which ate the corn diet (groups 4, 5, 6) showed a significant increase in the number and extent of carious lesions. Those of group 4 averaged slightly less than a fair score. The teeth of hamsters receiving sugar with the corn diet were in poor condition whether they received sodium oxalate or not with their diet.

Other investigators have noted in similar studies that male hamsters suffer from caries more than females. This trend is evident among most of the males in all diet groups of this experiment.

Life Span of Hamsters

Sixty of the hamsters originally selected for this study were kept until death from natural causes. Each group of 10 receiving the 6 different diets include 4 males and 6 females. The length of life in days is recorded in table 4, where the animals are grouped according to diet and sex.

The results of this study contrast with those usually reported for albino rats because there were old males still alive in 5 of the diet groups after the last female had expired. This difference is also reflected in the median values for each of the sexes.

In spite of the greater incidence of tooth decay in animals receiving the corn diets, there is no evidence that this phenomenon modified the span of life. Both of these major diets seem satisfactory for life span studies. These diets must have substantial margins of safety, or animals receiving them with large additions of sugar would have died prematurely. There is no evidence that long continued ingestion of a low level of oxalate has any effect upon the span of life.

TABLE 4. LIFE SPAN OF HAMSTERS (IN DAYS).

Group I Dog Meal		Group II Dog Meal and Sucrose		Group III Dog Meal and Sucrose with Oxalate	
Male	Female	Male	Female	Male	Female
215	600	855	587	365	550
215	616	921	588	446	656
858	642	971	742	754	695
966	643	1089	772	784	714
...	650	...	839	...	715
...	823	...	907	...	918
Group IV Corn		**Group V Corn and Sucrose**		**Group VI Corn and Sucrose with Oxalate**	
Male	Female	Male	Female	Male	Female
202	365	720	418	325	665
793	460	857	631	840	749
1000	599	892	711	1020	754
1054	607	1147	725	1064	819
....	610	....	773	....	832
....	623	....	791	....	841

Median values by sexes: Male 855 to 857
Female 665 to 695

The Quality of Bone in Old Hamsters

Unfortunately, part of the old animals were lost and there remained only 39 of them for studies to determine the quality of bone in old age. Methods which have been used in earlier work with rats were used here to evaluate the quality of bones (5).

Both humeri were dissected from the flesh, dried in air, extracted with ether, weighed, and given a thin coating of zein. The density was calculated after weighing the coated bones in air and when suspended in distilled water. After the densities were determined the bones were ignited in an electric muffle furnace for the estimation of ash and calcium content. The calcium was calculated in terms of milligrams per gram of bone and in terms of milligrams per milliliter of volume. In table 5, the calcium contents are expressed as percentage by weight and percentage by volume. The latter value has been found to be more useful in the study of old animals since the percentage by weight changes very little even when much of the bony substance has been lost. The percentage by volume relates the calcium content in weight to the volume of bone. As the shaft retains its

TABLE 5. QUALITY OF BONE IN RELATION TO DIET AND SEX.

No. of Animals and Sex	Average Weight of Humeri† (mg.)	S. D.	Average Volume of Humeri [λ].	S. D.	Mean Density*	S. D.	% Ash	S. D.	Calcium Content (% of Weight)	S. D.	Calcium Content (% of Volume)	S. D.
DOG MEAL DIETS												
7 Males	114	15.4	100	8.4	1.148	0.090	60.5	4.4	22.5	1.7	26.0	3.7
11 Females	130	24.5	113	14.5	1.176	0.101	63.6	2.1	22.4	2.0	26.3	3.3
CORN DIETS												
6 Males	96	11.9	99	10.2	0.984	0.074	53.6	3.4	20.1	1.5	19.8	1.8
9 Females	105	19.7	109	12.4	0.970	0.122	56.8	3.8	20.8	1.0	20.2	3.2
CLASSED ACCORDING TO SEX AND DISREGARDING DIETS												
13 Males	106	16.3	100	8.9	1.073	0.116	57.3	5.1	21.4	2.0	23.1	4.3
20 Females	118	25.3	111	14.5	1.083	0.151	60.5	4.6	21.7	1.8	23.6	4.5

* Calculated from weights and volumes of coated bones.
† Weights of uncoated bones.

volume, but becomes a thin shell, this percentage-volume value becomes very low.

Fortunately, the missing animals were distributed quite evenly among the sub-groups. Data are too meager for evaluating the effects of these sub-groups but there is no suggestion of differences except in diet group 6. Two samples of these are missing because during dissection crushing of the bone occurred due to unusual thinness of the shaft; volume cannot be measured on broken parts of bone.

The data in table 5 indicate that bones of animals fed on the corn or caries producing diets were inferior to those fed on dog meal. Females had heavier bones than males on either diet. While the average weight of humeri of males was less than that of females receiving dog meal, it was larger than the average weight of humeri of females on the corn diet. The average volume of humeri was practically identical for males receiving either diet and was only slightly larger for females on the dog meal diet. Animals fed either of the two diets attained the same adult size. However, the density, ash, and calcium were all higher in both sexes receiving the dog meal. This is unexpected because the corn diet contained 30 per cent of dried whole milk while the dog meal contained only 4 per cent of non-fat milk solids. Therefore, it seems that a diet which produced the high incidence of caries also produced the poorer bones in old age. No studies are known that relates these two factors in human beings.

In earlier studies of the densities of bones of old rats, (7, 9) the mean values for male rats ranged from 1.18 to 1.42 and the mean values for virgin females ranged from 1.28 to 1.50. This contrasts with the mean value of 1.073 for bone density for the 13 male hamsters and 1.083 for the 20 female hamsters in the present study. However, the humeri of 8 hamsters, which had been kept in the laboratory as stock animals, showed a range of densities of 1.15 to 1.46, with a mean of 1.26. This indicates that hamsters may have bones nearly as dense as those of rats. The hamster may serve better than the rat in studies of the changes in bone composition with age.

Thirty-five of the hamsters in the present study dying naturally were studied by Silberberg and associates (8). They reported that about a third of these had osteoarthritis. Due to a loss in records, no study could be made of possible interrelationships of arthritis to diet. In a more extensive study is it hoped to repeat and improve these observations.

SUMMARY

A group of 150 Syrian hamsters containing 102 females and 48 males was used to determine the effects of 2 different stock diets upon the decay of teeth and the deterioration of bones in old age. The diet rich in corn produced the usual early decay of teeth and also

bones of low density in old age. Supplementing these diets with sodium oxalate or replacing one-third of each diet with sucrose produced no change in the results, indicating that sucrose did not increase the tooth decay and oxalate did not protect the teeth. The span of life for the 60 animals kept until natural death had median values of 855 to 857 days for males and 665 to 695 days for females. Six males, out of 24, lived more than 1000 days while no female exceeded 918 days. The basal diets did not affect the span of life. In old age the density of bones was about 20 per cent less than that for rats of a comparable age while the difference between sexes was slight. The great group variability of hamsters fed different diets suggests that they may be very useful in the study of bone deterioration in old age. This study suggests that early decay of teeth may indicate more deterioration of bones in old age. Part of these animals developed osteoarthritis.

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DEFICIENCIES IN THE LIPOPROTEIN LIPASE SYSTEM IN ATHEROSCLEROSIS*

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Biochemical (5, 6, 8, 19, 30), electrophoretic, and ultracentrifugal (14, 18) techniques have provided evidence for the presence in atherosclerosis or atherogenesis of an apparent metabolic block or deficiency (28) which manifests itself chemically and electrophoretically by an increase in the β-lipoprotein fraction and a decrease in the α-lipoproteins of plasma or is manifested ultracentrifugally by a progressive increase in plasma low density molecules of lipoprotein nature.

The maintenance of a steady dynamic state in the intermediary metabolism of these lipoproteins seems to be mediated largely through an enzyme system [clearing factor system, (1, 3, 16) lipoprotein lipase system (20)] which manifests itself *in vivo* and *in vitro* by a decrease in the optical density of lipemic plasma. This system was first observed by Hahn (17) in 1943 when he reported that the injection of heparin caused the rapid disappearance of chylomicrons from the post-absorptive plasma of dogs. During the action of this system on low-density β-lipoproteins of plasma these components seem to be degraded in the direction of lipoproteins of higher density (16, 18); attendant to this reaction, the appearance of high density components with the ultracentrifugal properties of α-lipoproteins is observed (11, 25).

Collectively these results suggest that deficiencies in the lipoprotein lipase (LPL) system may be responsible for the accumulation of β-lipoproteins and the decrease in α-lipoproteins in atherosclerosis and atherogenesis. The work reported in this paper demonstrates and locates the presence of deficiencies in the LPL system of the human atherosclerotic subject.

MATERIALS AND METHODS

Pilot experiments conducted in this laboratory with LPL indicate the presence of lipase activity as based upon the release of free fatty acids from a sesame oil substrate. This observation, coupled with the report of Anfinsen (2) of a proportion existing between fatty acid release and clearing activity, along with the observations of Korn (20), was considered as adequate justification at this time for considering clearing factor in terms of a lipoprotein lipase, even though our results are reported in terms of units of O. D. (optical density) change. However, since the intermediary metabolism of fatty acids in the LPL system is inadequately understood, it is not justifiable to assume at this time that a proportionality exists in our studies between the O. D. change and the release of measurable free fatty acids.

A modified procedure of Brown, Boyle, and Anfinsen (13) was employed for the preparation of LPL. The precipitate of LPL was resuspended in 12 plasma volumes of distilled water at 0-2 C. and stirred for 2-5 hours after which the insoluble material was allowed to settle overnight. According to Brown and associates (13) the resulting precipitate was lyophilized at this point; however, we have found occasional contamination with cofactors at this stage and have therefore included one additional washing under the same conditions prior to lyophilization. This additional washing sufficed to eliminate cofactor activity as demonstrated by the absence of clearing in those reaction tubes omitting plasma but containing all other substrates (table 1). This preparation is stable and has retained its activity in this laboratory in excess of an 18 months' period. The magnitude of the results reported in this paper will be dependent upon the activity of the LPL preparation employed, i.e., a given

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enzyme preparation may be more or less active than preceding preparations. If it proved to be impossible to carry out all the desired experiments with one enzyme preparation, correction factors were employed.

Sesame oil* was available as a 0.5 per cent Tween 60 stabilized emulsion containing 10 per cent oil by volume and 5 per cent dextrose U.S.P. These emulsions were diluted to 1.0 per cent with 1:1 0.85 per cent NaCl-phosphate buffer (pH 7.2, $\Gamma/2 = 0.1$) for use as substrate in the LPL system.

Washed alimentary lipemic serum lipoproteins and chylomicrons were prepared by layering lipemic canine serum under 0.15 M sodium chloride in plastic tubes, centrifuging at 80,000 × G. in the Model L Spinco centrifuge for 30 minutes, and gently removing the top layer with a syringe equipped with a flat nosed, gauge 18 syringe needle. Following the initial isolation of the top layer, it was again layered under 0.15 M sodium chloride and spun and isolated as before. This procedure served to free the preparation of cofactor activity.

Non-crystalline serum albumin was procured from Bios Laboratories.†

Normal plasma samples were obtained from young men (Group 1, 20 to 33 years of age) without known disease and from older men (Group 2, 40 to 62 years of age) who were clinically diagnosed as normal. Pathologic plasma samples were obtained from male patients (33 to 81 years of age) with proved myocardial infarction. Since it is well known that more than 95 per cent of myocardial infarctions occur in people whose coronary arteries are atherosclerotic, an unequivocal myocardial infarction should serve as a thoroughly reliable index of the presence of atherosclerosis.

The minimum requirements for accepting a patient as an atherosclerotic subject were (a) a clinical and laboratory history of myocardial infarction, and (b) electrocardiographic changes characteristic of an infarction. In total, 67 patients with myocardial infarctions, 47 normal and 10 subjects with angina but without myocardial infarction were studied in the initial survey (fig. 1). It is known that the concentration levels of low density lipoproteins are markedly influenced by the relationship between the time of drawing the blood samples and the time and character of previous meals (6, 14, 30). For this reason, and in order to achieve in so far as possible basal conditions, plasma was drawn only from subjects who had fasted for a minimum of 8 hours overnight (generally 12 hours or more) prior to the time of taking the sample. Plasma samples (10 ml.) were immediately stored at 2-4 C. following drawing into trisodium citrate and were analyzed within 25 hr. of the time of drawing. No significant change in cofactor activity was found to occur under the prescribed conditions.

To eliminate the possibility of recording metabolic variables occurring only during the period of recovery from an infarction, results are recorded only if the infarction had occurred at least 6 weeks before blood was drawn for analysis.*

In all the experiments, unless otherwise indicated, the incubation vessel contained 0.3 ml. of LPL (10 mg./1 ml. buffer), 0.15 ml. of citrated plasma, 0.1 ml. of 1 per cent sesame oil, and 0.45 ml. of 1:1 0.85 per cent NaCl-phosphate buffer (pH 7.2, $\Gamma/2 = 0.1$). All solutions were prepared with this buffer and maintained at 2-4 C. until incubated at 37 C. The incubation vessel consisted of 10 × 75 mm. Pyrex test tubes which had been standardized with respect to O. D. Incubations were carried out for a standard period of 5 hr. with each tube being read in a given time sequence so that all tubes were read with each possessing the same incubation time prior to the given O. D. determination at 700 mμ with a Coleman Junior spectrophotometer. All analyses were run in duplicate and the results are reported in decrease in units of O. D. × 1000.

RESULTS

Analysis of the Analytic Method.—The results given in table 1 indicate: (a) the reproducibility of an analysis on a given sample provides a standard deviation of 1.7 (per cent), (b) sesame oil is completely stable during the 5-hr. period of incubation, thus indicating the absence of any interference by O. D. changes resulting from an unstable oil emulsion, (c) in each set of experiments duplicate determinations were made of the clearing, if any, in the presence of sesame oil, buffer, and LPL, but with plasma omitted. It will be observed that all LPL preparations used were free of cofactor contamination, as indicated by the absence of

* Generously supplied by Dr. Douglas Frost of Abbott Laboratories, Chicago.

† Bios Laboratories, 17 West 60th Street, New York City 23.

* Exception to this rule was taken if a patient had been studied for 4 weeks from the time of infarct with no significant change in cofactor activity.

TABLE 1. ANALYSIS OF THE ANALYTIC METHOD.*

Criterion	Number of Samples	Standard Deviation (%)	Mean Initial O. D. (Units)	Mean Final O. D. (Units)
Reproducibility of an analysis on a given sample	284	1.7	...	...
Stability of sesame oil in buffer	25	...	580	581
Stability of sesame oil, buffer, and LPL	262	...	592	600
Stability of sesame oil, buffer, and plasma	21	...	620	624
Contribution of the lipolysis of fasted atherosclerotic plasma, in presence of 3 mg. of LPL, to turbidity changes	24	...	30	22

* All analyses were conducted at 37 C. for 5 hours.

clearing with the exception of the essentially negligible clearing for the LPL preparations used in figure 4 and 5, (d) no clearing occurred when plasma was incubated with the substrate in the absence of LPL, and (e) if low density lipoproteins, such as S_f 20-30, which have been claimed not to contribute appreciably to the turbidity of the plasma, are attacked by LPL they might increase the O. D. by enlarging the concentration of the Ca salts of the fatty acids. Thus, if these lipoproteins were sufficiently elevated in the fasted atherosclerotic person, they could theoretically account for the differences observed. This could not be considered as a deficiency or defect in cofactors. However, the results (table 1) indicate that an increase in turbidity does not occur upon lipolysis of atherosclerotic plasma; rather a very small decrease occurs. Essentially the same results were obtained for normal young male subjects.

Description and Analysis of an LPL System Deficiency in Atherosclerosis—Figure 1 summarizes the results with respect to the activity levels of cofactor in normal and atherosclerotic subjects. The following conclusions are drawn from these data:

1) There exists a highly significant correlation between the level of cofactor activity in 114 Caucasian subjects and the presence or absence of atherosclerosis as indicated by myocardial infarction.

2) All 67 patients with proved myocardial infarction demonstrate a deficiency. This observation would be fully anticipated if this deficiency is directly related to the development of atherosclerosis.

3) In the age group over 40 there occurs a significant drop in the activity of cofactor for the 28 normal and questionable normal (angina) subjects studied. This deficiency may be significantly correlated with the observations by Gofman and associates (14) of an increase in the incidence of measurable concentrations of lipoprotein molecules of the S_f 10-20 class in the age group over 40 years. It may be pointed out that these authors have demonstrated a significant correlation between the S_f 10-20 molecules and atherosclerosis. In addition there occurs a progressive decline in activity with increasing chronologic age. This trend is true for the clinically normal as well as the atherosclerotic individual; however, in the atherosclerotic, for the same age group, there occurs an appreciably greater deficiency of cofactor. This chemical change is to be anticipated from histopathologic data (27) which demonstrate the progressive development of atherosclerosis with age.

4) An intermediary zone of clearing can be arbitrarily established which contains an equivalent number of proved myocardial infarctions and normal subjects. It is particularly noteworthy that no proved myocardial infarction exists above this zone, while only 3 of the normal subjects fall below. Of the angina subjects, 2 fall above the zone but close to it, 3 fall within the zone, while 5 fall below.

Observations that 50 per cent of the normal and questionable normal persons (subjects with angina) in the age group over 40 appear in the intermediate zone or below is to be expected from known pathologic data which demonstrate (29) that approximately half of the population in this age group are developing atherosclerosis, even though the disease has not been manifest clinically.

5) There is present in the literature considerable discussion over the senescence theory of the genesis of arteriosclerosis or atherosclerosis. Katz and Stamler (19) have reviewed the problem and have cited references containing indisputable postmortem evidence demonstrating that clinically significant, marked atherosclerosis (among the arteriosclerosis) undoubtedly occurs in some very young people and undoubtedly is minimal in some very old people. They further state that the fact that aged persons may be almost free of atherosclerotic lesions at

autopsy and that young people may fall victim to its lesions demonstrates that aging is not essential for atherogenesis.

The conclusions which may be drawn from figure 1 are pertinent to resolving the preceding problems. These conclusions should, however, be qualified by pointing out that larger numbers of normal subjects between the age of 30 and 40 and over 60 will be helpful in establishing significance. Figure 1 scattergraph demonstrates a progressive decrease in the activity of the LPL system cofactor or cofactors with time and it indicates at a given age, superimposed upon the deficiency occurring with increasing chronologic age, an additional deficiency in the atherosclerotic.

If a curve for the normal subjects is constructed and extrapolated it will extend into the pathologic area of the graph. Thus all normal persons will apparently have a pathologic condition with time or aging. Seventy to 80 years seems to represent the chonologic age limit when essentially all subjects will have entered the pathologic range. This observation may be reconciled with postmortem findings, as related to chronologic age (19), if one considers atherosclerosis as an integral part of biochemical aging rather than a truly specific manifestation of chronologic age. Perhaps to recognize atherosclerosis as a manifestation of biochemical aging would indeed be a major break-through to understanding and ultimate elimination of those biochemical deficiencies which are progressive with time and may potentially cause the disease.

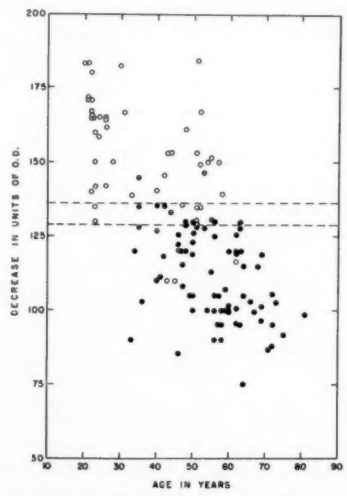

Fig. 1. The plasma activity of LPL cofactor of 124 normal and atherosclerotic subjects are presented in a scattergraph form. Each point represents two or more analyses.

○ = Normal
● = Pathologic
⊙ = Angina

6) In a discussion of cause and effect a relevant question is which came first, (a) the piling up of low density lipoproteins or, (b) the deficiency in the system for metabolizing them. Pertinent to this question are the observations of relative susceptibility to cholesterol-induced atherosclerosis (28). Thus, generally, animals least susceptible have the most active systems for metabolizing cholesterol. The studies of Becker and associates (6), of Schwartz and associates (30), and of Block and associates (8) on alimentary lipemia also suggest a deficiency in the system for metabolizing chylomicrons and low density lipoproteins, but the data might also be interpreted to indicate increased fat absorption and increased synthesis of low density lipoproteins, thus causing a greater utilization of a cofactor in the pathologic subject. This would show up in our experiments as a deficiency. It should, however, be noted that our subjects fasted overnight before donating their blood sample and as a result the initial units of O. D. readings in the presence of sesame oil were generally the same, $\pm$ 5, for normal and pathologic persons. This indicates that the pathologic subjects had attained a basal state with respect to alimentary lipemia. In addition the study of the effect of increasing the concentration of plasma on the LPL system (fig. 4 and 5) indicates the absence in vitro of non-turbid low density lipoproteins which would be utilizing cofactor. Thus the available data suggest that a cofactor deficiency represents an unknown fraction of the cause, and the piling up of low density lipoproteins represents effect in the atherosclerotic patient.

In any discussion of whether the cofactor deficiency represents cause or effect in relation to the development of atherosclerosis, it would be well to keep in mind that we are here dealing with a factor or factors necessary for the metabolism of low density lipoproteins which accumulate in atherosclerosis (2, 14, 18) and species of which have been demonstrated to be atherogenic (12).

Effect of Variable Concentrations of LPL Upon Clearing.—LPL prepared as described

TABLE 2. THE EFFECT OF PROTHROMBIN AND FIBRINOGEN UPON THE LPL SYSTEM.*

Fibrinogen (mg.)	Thromboplastin (mg.)	Prothrombin (mg.)	LPL (mg.)	Mean Initial O. D. (Units)	Mean Final O. D. (Units)	Clotting	No. of Experiments
0	0	3	0	585	580	−	2
0	0	1	3	600	477	−	2
0	0	0	3	605	475	−	2
2	1	0	3	−	−	+	2
0.45	0	0	3	598	470	−	2

* Prothrombin, thromboplastin, and fibrinogen were obtained from Bios Laboratories, Inc., 17 West 60th Street, New York City 23. All preparations were free of thrombin.

above is not a pure enzyme. Experiments conducted in our laboratory indicate that small amounts of prothrombin and fibrinogen are contained in the preparation; however, neither of these substances affected the activity of LPL (table 2).

The concentration of 3 mg. of LPL in the reaction tubes gives rise to approximately 95 per cent of the maximum clearing obtainable in the presence of 0.36 ml. of citrated normal human plasma (fig. 2). Increased amounts, 3.5 or 4.0 mg., of LPL did not increase the total clearing by more than 5 per cent. However, if the clearing capacity of normal versus atherosclerotic patients is determined with LPL preparations of lower activity and lower concentrations, there still occurs a marked difference between the two experimental groups (fig. 3). The data indicate that, with increasing concentration of LPL, the clearing of the atherosclerotic subjects represents essentially a constant proportion of the clearing value for the normal individuals.

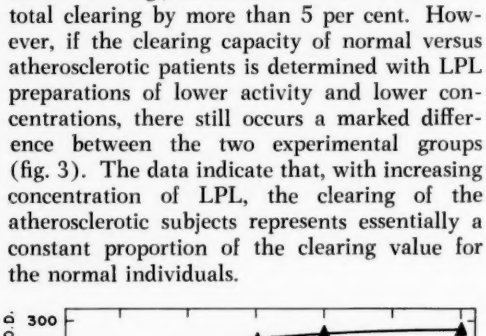

Fig. 2. The effect on O. D. change of increased amounts of LPL. The incubation mixture contained 0.36 ml. normal citrated plasma, 0.1 ml. of 1% seasame oil, and 0.24 ml. physiologic saline. In addition each tube contained the amount of LPL specified plus 0.85% NaCl-phosphate buffer (pH 7.2, $\Gamma/2 = 0.1$) to make up to 1 ml. total volume. Incubation time = 7 hours.

Fig. 3. Effect of increased amounts of LPL (specific activity < fig. 2 LPL) on the O. D. change of normal and atherosclerotic plasma. Incubation mixture contained 0.15 ml. citrated plasma and 0.1 ml. of 1% sesame oil. Each tube was made up to volume with NaCl-phosphate buffer and contained the amount of LPL specified. Incubation time = 5 hours.

All of the preceding results are to be fully anticipated if indeed there is extant a deficiency of factors required for the full activity of the LPL system.

Effect of Decreasing the Concentration of Plasma upon the LPL System—Figure 4 is a comparison of the clearing activity of normal versus pathologic plasma in the previously de-

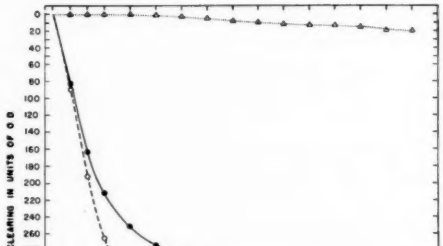

Fig. 4. Comparison of the clearing activity of 22 normal males and 25 male atherosclerotic subjects. The complete incubation mixture contained 0.6 ml. citrated plasma, 0.1 ml. of 1% sesame oil, and 0.3 ml. of LPL (10 mg. of LPL per ml. of 1:1 0.85% NaCl-phosphate buffer [pH 7.2, $\Gamma/2 = 0.1$]). The blank runs consisted of a mixture of 0.3 ml. of LPL, 0.1 ml. of 1% sesame oil, and 0.6 ml. of NaCl-phosphate buffer.

Code:
Blanks = —△— △—
Atherosclerotic = —●— ●—
Normal = - -○- - ○- -

scribed in vitro system. The pathologic curve represents the average of the results obtained for 25 male atherosclerotic subjects whose ages varied from 37 to 76 years (average age = 64 years). The normal curve represents the average plot of results obtained on 22 normal young males (21 to 37 years of age, average age = 24 years). It will be observed that at the 20 minute reading a difference between the clearing ability of the older atherosclerotic subjects and the normal young subjects begins to appear. There occurs a progressive decrease in the rate of clearing of the atherosclerotic curve as referred to the rate of clearing of the normal. The reaction has essentially completely leveled off at the end of 4 hours. The total clearing activity observed for the pathologic subjects is approximately 84 per cent of the observed value of the normals.

In figure 5 the same type of experiment was carried out with the plasma of the subjects reported on in figure 1, with the exception that the amount of plasma used was reduced by 75 per cent. The result of this dilution of plasma factors slowed the rate of clearing, e.g., in figure 4 for the normal subjects during the period of 20 to 40 minutes after the onset of clearing there occurred a clearing of 104 units of O. D. as compared to a clearing of 30 units of O. D. for the same period for the normal persons shown in figure 5. The total clearing for the normal persons was reduced by 90 O. D. units by the dilution of the plasma, and the total clearing for the pathologic subjects was reduced about 120 O. D. units. In using the diluted plasma samples, the total clearing activity observed for the atherosclerotic subjects was observed to be about 69 per cent of the value observed for the normal. Thus the effect of dilution demonstrates the need of some factor or factors in the plasma besides heparin activated LPL for normal clearing.

The question as to whether the atherosclerotic deficiency can be explained by the in vitro utilization of enzyme cofactors in the metabolism of larger quantities, if existent, in the atherosclerotic of non-turbid low density lipoproteins is of importance. Equal quantities of the cofactor or cofactors could theoretically be present in both the normal and the pathologic plasmas; however, if part of the concentration of cofactors were used in the pathologic plasma for the metabolism of excess quantities of non-turbid lipoproteins, then less of the cofactors would be available for the metabolism

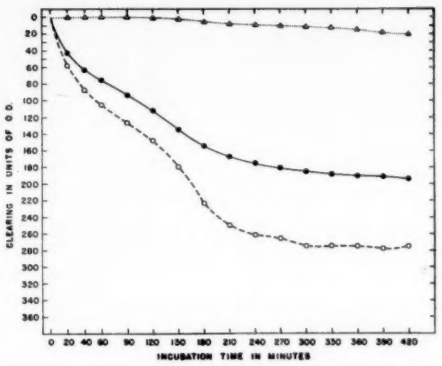

Fig. 5. Comparison of the clearing activity of normal and atherosclerotic human plasma. The complete incubation mixture contained 0.15 ml. citrated plasma, 0.1 ml. of 1% sesame oil, 0.3 ml. of LPL and 0.45 ml. of NaCl-phosphate buffer. The code and plasma samples are the same as for figure 4.

or O. D. decrease of sesame oil. That this can not be the case is demonstrated by figures 4 and 5 where a 4-fold increase in the concentration of plasma, normal and pathologic, decreased the deficiency rather than increased it. Thus 90 units of difference between the normal and pathologic at 0.15 ml. of plasma would be expected to be enlarged upon rather than decreased when 0.60 ml. of plasma were used if the cause of the deficiency were due to excess quantities of non-turbid low density lipoproteins. One would not, however, anticipate a linear increase in the difference, since a reaction of this nature should provide a curve similar to the plot of a first order reaction.

The results shown in figures 4 and 5 also indicate the relative absence of an inhibitor for LPL.

Effect of Albumin upon the LPL System Deficiency.—Acceptance by albumin of fatty acids was demonstrated by Ballou, Boyer, and Luck in 1945 (4). A role for albumin in the acceptance of fatty acids in the LPL system would therefore be expected and was indeed demonstrated by Gordon and associates in 1953 (15). It has also been pointed out (15) that much of the earlier work on the nature of coprotein (3) must be considered to reflect to a considerable degree the reactions of albumin. Thus the necessity for the presence of albumin in the LPL system has been well indicated. It was therefore of interest to determine if albumin would replace the LPL system deficiency. Albumin alone would not serve as a replacement for plasma, i.e., a combination of LPL, sesame

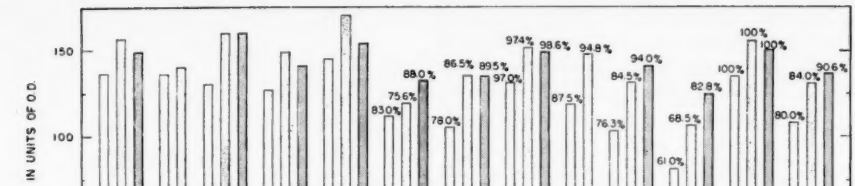

Fig. 6. Effect of albumin on the LPL system deficiency in atherosclerotic patients. The percentage value at the top of the pathologic columns indicates the percentage of the normal for the given albumin concentration. LPL = 10-15-56. N. = Normal P. = Pathologic M.I. = Myocardial Infarction

oil, and albumin would not provide any decrease in O. D.

The data in figures 6 and 7 summarize all the findings with respect to the effect of graded concentrations of bovine albumin on the activity of the LPL system in normal and atherosclerotic subjects. The following conclusions are drawn from these data:

1) It is generally accepted that the range of plasma albumin concentration varies from 3 to 6 Gm. per cent in the normal human adult. This concentration of the protein may be considered to represent a steady state in a dynamic equilibrium and consequently the effective concentration of albumin during a 5-hr. period may or may not represent the designated normal concentration. The turnover rate or the biologic half life, T ½, has been reported (26) to extend from 9 to 10 days to over 200 days. Many of the values were observed to be around 20 days for iodoalbumin and 35 days for albumin – S^{35}. This latter observation indicates that it cannot be assumed that T ½ for the parts is the same as for the whole. In view of the lack of information on the turnover time of lipo-albumin one cannot predict the concentration of albumin which is active in accepting fatty acids for a given time. With these considerations in mind it was determined to employ albumin concentrations in excess of the normal plasma concentration.

Of the 10 cardiovascular subjects, 9 were distinctly deficient in the absence of exogenous bovine albumin; 1 subject, R. C. (fig. 6), seems normal with respect to the normal mean. In the presence of 5 per cent exogenous bovine albumin, 1 subject, L. G. (fig. 6), out of the 9 deficient subjects seems to have been rendered essentially normal, attaining 94.8 per cent of the normal mean value in the presence of 5 per cent exogenous albumin. The interpretation of the results attained in the presence of 10 per cent albumin or higher is difficult in view of the inhibition of the normal clearing. This inhibition with 10 per cent albumin is universal in the normal individuals (fig. 6) whereas in the experiments reported in figure 7, inhibition does not appear until 20 per cent albumin is employed. This inhibition also appears in the pathologic subjects as evidenced by both figures 6 and 7. The cause of the inhibition anomaly is unknown.

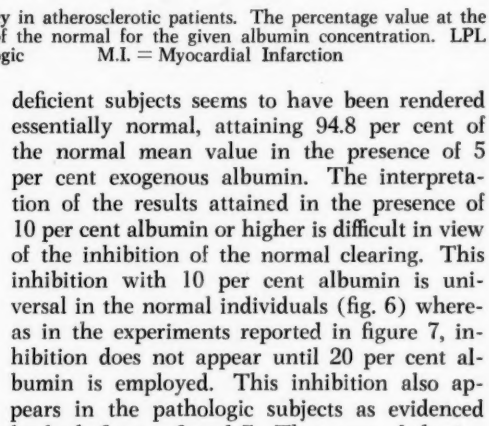

Fig. 7. Effect of albumin on the LPL system deficiency in presence of enzyme preparations possessing different specific activity. Code is the same as for figure 6. P — F.M. is a diabetic patient and at the time of analysis had not sustained a myocardial infarction.

2) Non-crystalline bovine serum albumin failed in most cases to replace the observed deficiency in the LPL system of the atherosclerotic subjects.

3) In most cases bovine serum albumin tended to reduce the magnitude of the deficiency in the LPL system. This effect is demonstrated by a decrease in the difference existing between the individual pathologic patient and the normal mean when albumin is added as a substrate to the reaction tube.

The therapeutic action of albumin in the atherosclerotic LPL system is to be anticipated in view of the association between deficient levels of serum albumin and disease states which are accompanied by an increased incidence and severity of atherosclerosis, i.e., nephrosis (7, 24), diabetes (7; and fig. 7), and induced hypercholesterolemia and subsequent atherogenesis (9). Kritsman and Bavina (10, 22) have indeed shown that a reduction in the synthesis of protein and heightened proteolysis occur in the atherosclerotic rabbit.

4) These studies indicate a deficiency of factors in addition to albumin in the plasma of the human atherosclerotic.

Effect of Low Density Lipoproteins upon the LPL System Deficiency.—The analysis of citrated plasma, received from 6 normal and 12 atherosclerotic subjects (fig. 8) in the presence of LPL and washed alimentary lipemic plasma lipoproteins and chylomicrons, revealed the presence of a deficiency similar to that observed for sesame oil.

Besides confirming the observations made upon sesame oil, a further analysis of the results obtained with the low density lipoproteins suggests a reduction in the magnitude of the deficiency. The results recorded in the scattergraph represent preliminary experiments employing two different preparations of lipoproteins and two different LPL preparations. The trend toward a reduction in the deficiency was present in all of the statistical means (table 3). However, the average deviation for the sesame oil experiments in Group 1 is abnormally large, sufficiently so as to render the results unacceptable excepting for the fact that the average per cent of the normal clearing falls close to the value of Group 2, which has a small average deviation. Whether or not these results on the difference between sesame oil and low density lipoproteins can be considered to be significant must await a larger numbers of cases. If the results are significant, they suggest that a part of the atherosclerotic deficiency in the LPL system involves activation, probably activation by protein, of the lipids. This conclusion is reinforced by the observations by Korn of lipid activation (21).

It would seem from the available evidence that atherosclerosis can gradually and progressively develop as a result of multiple chemical defects which develop and become progressively more severe with time, defects, or deficiencies which have all too often in the past been termed normal for the given chronologic age and subsequently ignored from the pathogenic as well as the therapeutic point of view. The term, "normal adult level of an enzyme or metabolic factor," should probably be restricted to those values commonly obtained from subjects before the age of 35 to 40 years. All deviations from these levels, regardless of the adult chronologic age at which they occur, should be considered as abnormal and as reflecting pathogenic processes.

Effect of Time on the Activity of the LPL System Cofactors of Atherosclerotic Patients.—The data in figures 9 and 10 summarize the results obtained on patients examined with respect to changes occurring in cofactor activity with time following the onset of a myocardial

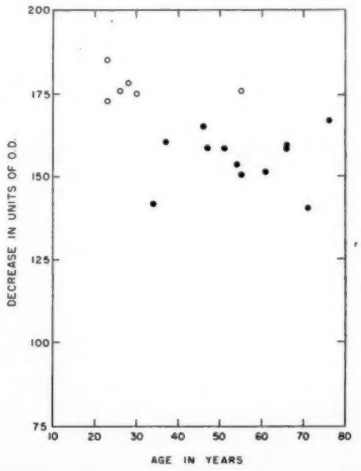

Fig. 8. Effect of low density lipoproteins on the LPL system deficiency. Incubations were performed as described in Materials and Methods with exception of replacement of sesame oil substrate by low density lipoproteins and chylomicrons.

○ = Normal
● = Pathologic

TABLE 3. COMPARISON OF THE CLEARING OF LOW DENSITY LIPOPROTEINS AND SESAME OIL IN NORMAL AND ATHEROSCLEROTIC SUBJECTS.

Group	Percentage of Normal Clearing in Atherosclerotic Patients		Number of Subjects in Each Group
	Sesame Oil	Low Density Lipoproteins	
1.	67.3 ± 24.7	82.6 ± 6.0	3 N* 8 P†
2.	69.2 ± 2.4	83.4 ± 1.6	3 N* 4 P†

* N = Normal.
† P = Pathologic.

infarction. Figure 9 represents a composite of the individual curves of living subjects shown in figure 10.

Plotting the results of all living coronary patients into a scattergraph (fig. 9), indicates an increase in cofactor activity up through the thirtieth day following infarction. Following this point there seems to be no further significant change in cofactor activity, yet the plateau level falls well below that of normal subjects (fig. 1).

The data shown in figure 6 on patients who sustained a myocardial infarction more than 8 weeks prior to the time of donating a plasma sample also show no correlation between the time since the myocardial infarction and cofactor activity.

From figure 9 (larger numbers of cases will be helpful in establishing significance) it may be tentatively concluded that cofactor activity levels are significantly related to the onset of myocardial infarction, i.e., the lowest activity level of the curve seems to occur at the onset of myocardial infarction.

The question arises as to the possibilty of the muscle injury of myocardial infarction causing the observed cofactor activity change. In the case of glutamic oxaloacetic transaminase, which is released from infarcted myocardial tissue (23), the activity of the transaminase increases abruptly following myocardial infarction and then returns to normal within 3 to 6 days. In the case of LPL cofactor, the activity is subnormal prior to myocardial infarction, the activity does not return to normal after myocardial infarction, and at the time of myocardial infarction and for some time thereafter the cofactor activity is well below the average subnormal value of the recovered patients (fig. 1). These observations are in distinct contrast to

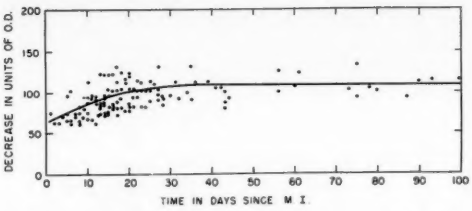

Fig. 9. Effect of time on the activity of the LPL system cofactors in atherosclerosis. This curve represents a composite of the curves of living patients in figure 10.

M.I. = Myocardial Infarction

transaminase which is in a normal range both at the time of infarction and after the patient recovers. It can be concluded that muscle injury of myocardial infarction is not responsible for cofactor deficiency and that the cofactor deficiency is part of the etiologic chemical sequence of events which led up to and culminated in a myocardial infarction.

Of further interest and possible significance to the previous discussion is the observation that patients C. D. and H. H. possess strongly negative slopes of cofactor activity with time. H. H., the only female patient studied in this series, and C. D. died 26 and 6 days, respectively, following the last analysis. All other patients are alive and recovering. Patient W. C., who possesses a curve marked by abrupt changes in slope and large variability in cofactor activity, has had recurrent bouts of extreme precordial pain. Since the times of these bouts are unknown, they have not been correlated to the changes in slope. Conferring of any prognostic significance to these observations must await studies on larger numbers of cases.

SUMMARY

A significant deficiency of cofactor activity in the lipoprotein lipase system has been found in the plasma of atherosclerotic patients.

The deficiency sustains a progressive decline in activity with progressive chronologic age. The role of cofactor activity is discussed in reference to its serving as an index of biochemical age.

For a given age group the atherosclerotic patient sustains a deficiency in cofactor activity which is in addition to the age deficiency of the clinically normal.

The curve of cofactor activity versus chronologic age indicates that all subjects will even-

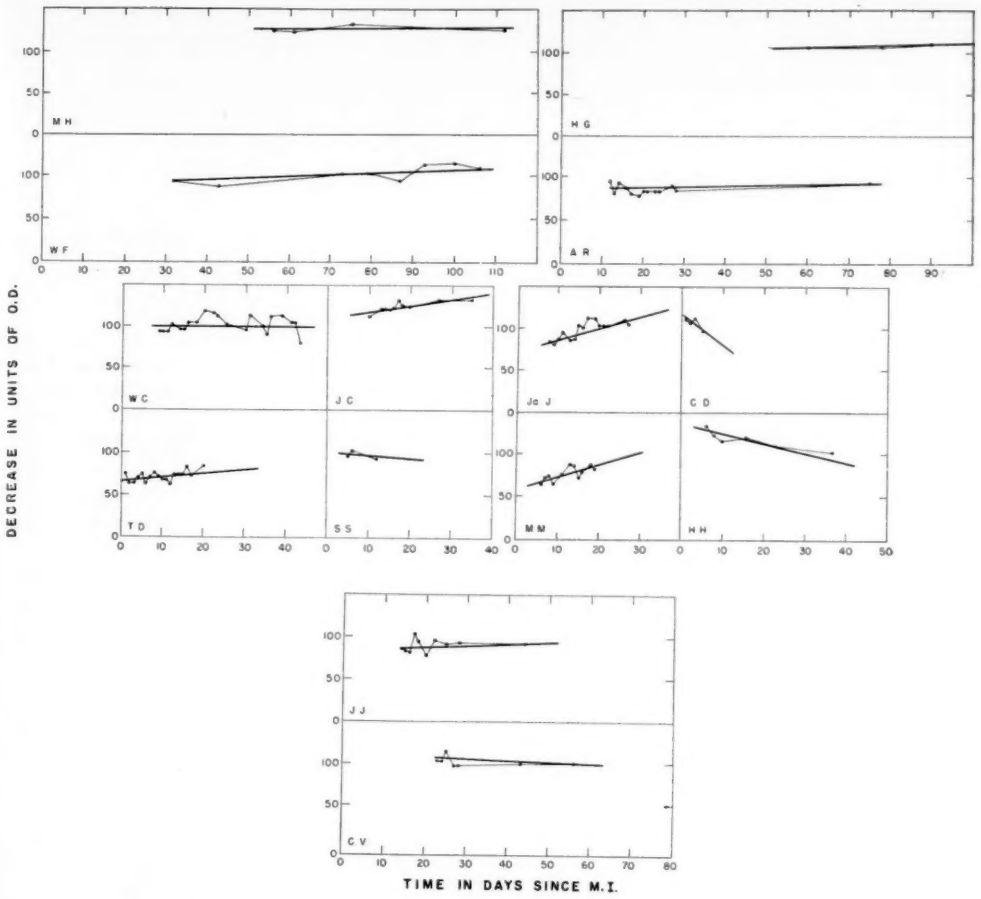

Fig. 10. Effect of time since sustaining a myocardial infarction on the activity of the LPL system cofactors in individual patients. Patients H. H. (the only female studied in this series) and C. D. died 26 and 6 days, respectively, following the last analysis.

tually sustain pathologic levels of cofactor activity.

Albumin has been found to correct a part of the deficiency.

Preliminary experiments suggest that a part of the deficiency represents inadequate activation of lipid by protein.

Preliminary experiments suggest a relationship between the activity levels of cofactor and the onset of myocardial infarction.

The relationship between biochemical aging and atherosclerosis is discussed.

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OSTEOPOROSIS IN THE AGED: RADIOGRAPHIC SURVEY WITH CLINICAL AND BIOCHEMICAL CORRELATIONS

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The published clinical studies of osteoporosis have for the most part been based on comparatively small groups and have been limited to symptomatic cases. Few surveys of aged people, regardless of symptoms, have been reported. The availability of a large number of individuals over age 65 years who could be observed under controlled conditions for periods of many years has prompted us to initiate a long range investigation of bone changes in the aging.

The purpose of the present study was to survey a large group of aged individuals to determine the age and sex incidence of radiographic osteoporosis and to correlate clinical and biochemical data with the degree of bone change.

MATERIALS AND METHODS

The series consisted of 565 patients (218 males and 347 females) who were residents in a geriatric facility (Brooklyn Hebrew Home and Hospital for the Aged). All individuals were past 65 years of age and exhibited varying degrees of chronic degenerative disease resulting in negligible to marked disability.

Standard methods were employed in obtaining the clinical laboratory data. Detailed histories and physical examination provided the clinical information.

The radiologist had no knowledge of the patient whose film he was evaluating. The roentgenographic findings were graded into 5 categories, 0 to IV in ascending degree of osteoporosis. "Blind" rechecking by the radiologist showed a variation of not more than one grade; the greatest difficulty was experienced in differentiating the 0 and I groups. The grades were therefore designated as follows:

Grade 0 = normal
Grade I = earliest stages — equivocal
Grade II, Grade III, Grade IV } = significant osteoporosis

Typical x-rays are demonstrated in figure 1.

Radiologically, the factors evaluated were: demineralization, atrophy, and the consequent softening. Demineralization was judged by the degree of "whiteness," which, in turn depended on the amount of rays penetrating through to the film. Atrophy was evaluated by the thickness of the vertebral cortices and disappearance of trabeculae in the spongiosa, e.g., a mesh-like box progresses to a hollow paper shell. Softening was evidenced by 1) invasion, by pressure, of the disc into the bodies of adjacent vertebrae; 2) collapse; 3) exaggerated curves of the spine.

The laboratory tests performed included determinations of hemoglobin, blood sugar and urea nitrogen, serum calcium, phosphorus, alkaline and acid phosphatase, total protein, albumin, and globulin. These measurements were carried out by standard procedures.

The clinical roentgenographic and laboratory data were coded and entered on punch cards which were used for the subsequent tabulations.

Since hyperthyroidism may induce marked osteoporosis and administration of desiccated thyroid increases the calcium excretion in euthyroid individuals (3) the thyroid function was studied in 54 cases (15 males and 39 females) through measurement of the 24-hour thyroid uptake of I^{131}.

Determination of fasting vitamin A plasma levels and the performance of vitamin A tolerance tests were carried out in 5 individuals as indices of the absorption of fat soluble vitamins.

RESULTS

The over-all picture is presented in figure 2. The findings show that the incidence of all grades of radiographic osteoporosis is higher in females than in males. Almost 100 per cent of the females show some degree of change, as do approximately 85 per cent of males. However, if the incidence of significant osteoporosis (grade II-IV) is considered, the sex difference becomes marked, there being a three-fold increase in females as compared to males.

This increased incidence of osteoporosis in females is true for all age groups studied (fig. 3). The marked difference in the incidence curves in males and females was an unexpected finding (fig. 4). The incidence of significant

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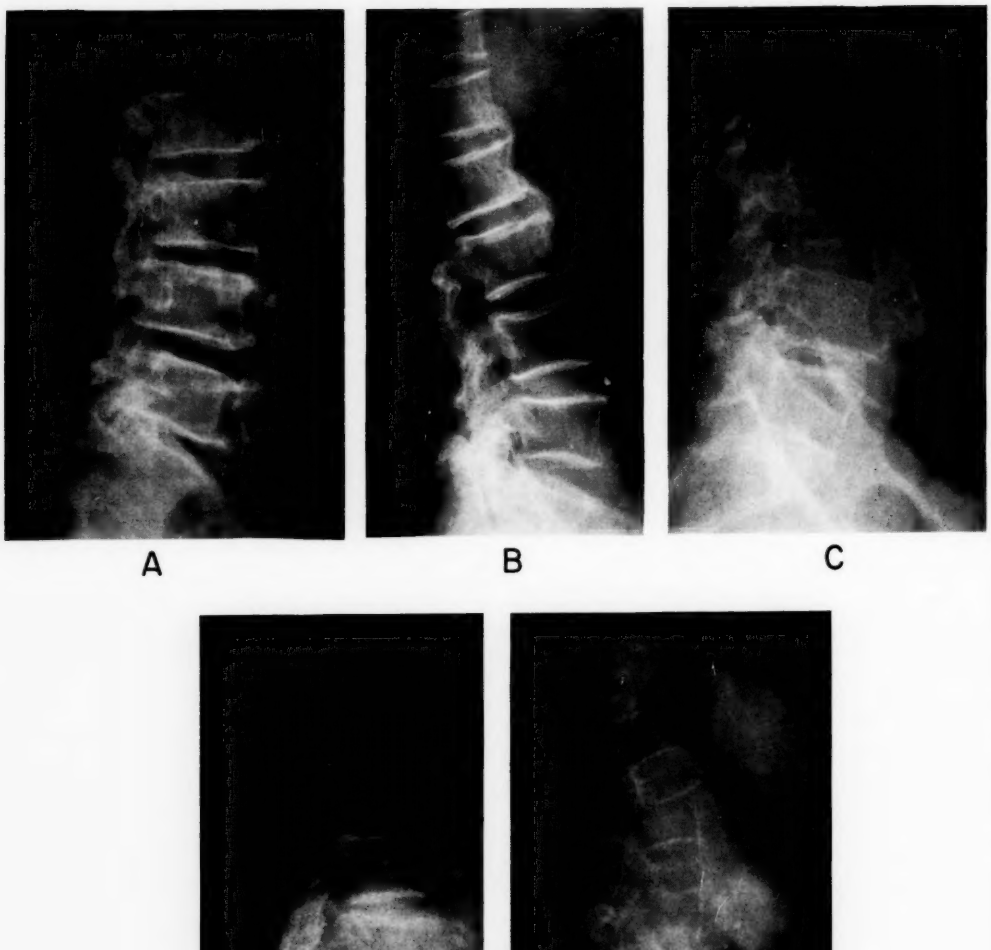

Fig. 1. Classification of Radiographic Osteoporosis: A) "normal," B) Grade I, C) Grade II, D) Grade III, E) Grade IV.

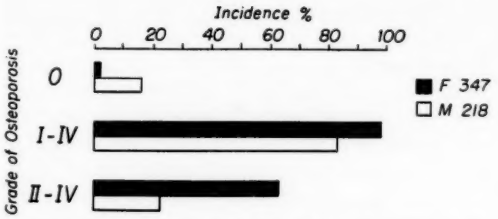

Fig. 2. Incidence of Radiographic Osteoporosis in Entire Series.

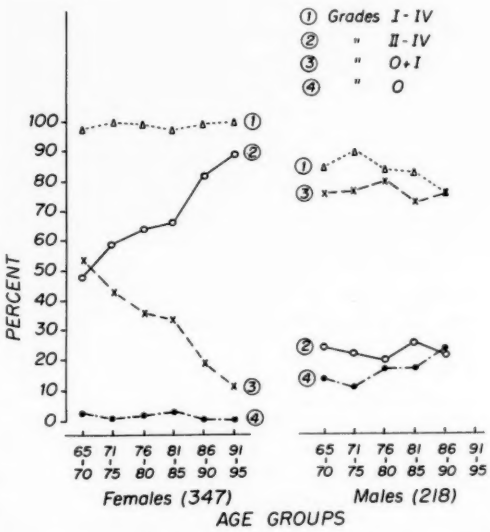

Fig. 3. Incidence of All Grades of Osteoporosis According to Age and Sex.

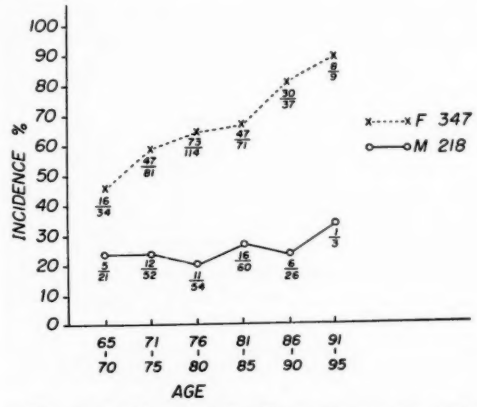

Fig. 4. Incidence of Significant Osteoporosis. The Numerator Denotes the Number of Individuals Exhibiting Grade II-IV Changes, and the Denominator the Total Number in the Age Group.

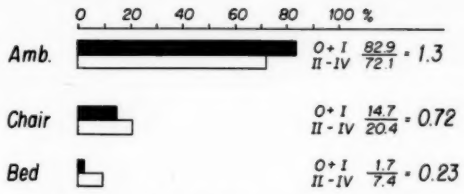

Fig. 5. Status of Ambulation and Osteoporosis.

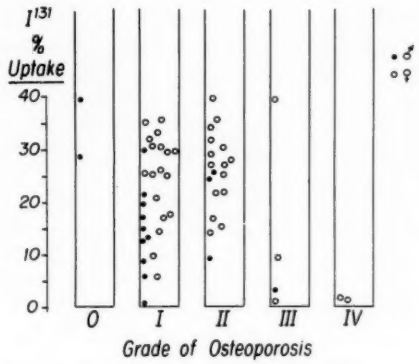

Fig. 6. Thyroid Function and Osteoporosis.

osteoporosis remains essentially constant in males from 65 to 70 to the 91-95 year group. This is in contrast to the findings in females who show a definite rise and a 100 per cent increase over the same age periods.

The correlation between the degree of ambulation and osteoporosis is not immediately apparent (fig. 5); 72.1 per cent of the patients showing grade II-IV changes were ambulatory as compared to 82.9 per cent of grade 0 + I individuals. However, if the ratio of

$$\frac{\%\ (0 + I)}{\%\ (II\text{-}IV)}$$

is calculated for the three major categories of ambulation, there is a progressive decrease as we proceed from ambulatory to bedridden status. This seems to indicate that the absence of physical activity plays a role, but only a minor one, in the pathogenesis of osteoporosis of the aged.

In discussions of diagnosis and therapeutic aspects of osteoporosis, back pain generally assumes an important role. We have found no significant correlation between the presence of back pain and the degree of osteoporosis—24.6 per cent of patients with grade 0 + I com-

plained of back pain compared to 27.9 per cent in grade II-IV cases.

No significant correlation was noted between the degrees of osteoporosis and the following values: hemoglobin, blood calcium, phosphorus, alkaline and acid phosphatase, sugar, urea nitrogen, total protein, albumin, and globulin. This is merely confirmatory of much of the data in the published literature. It serves only to underscore the futility of this approach.

The study of the thyroid uptake of I^{131} (fig. 6) and the vitamin A serum values and tolerance tests likewise failed to show any correlation with the degree of osteoporosis. No relationship was found either between clinical signs of vitamin deficiencies and abnormal body weights and the bone pathology.

DISCUSSION

The high incidence of osteoporosis in our series is of interest. It must be remembered, however, that our study deals with institutionalized persons, all showing degenerative processes of varying degrees. This may not be a true reflection of the incidence in the aged population of the community. Nonetheless, it is very likely that the gross incidence is higher than one deduces from the literature, because most cases, being asymptomatic, do not come to the attention of the physician. Another factor is the insidious development of the condition on the basis of the small daily calcium loss occurring in many aged individuals (4). It would take many years for bone to lose approximately 30-40 per cent of its mineral content which is necessary for radiographic detection (7, 10). Our studies will be expanded to include non-institutionalized individuals to determine any differences in incidence.

The marked sex differences in the incidence of osteoporosis is difficult to explain. In a series of 289 osteoporosis patients, 40-60 years of age, Anderson reported only 55 were males (2).

It has been stated (9) that post-menopausal osteoporosis is caused by decreased osteoblastic activity due to decreased estrogens. This, however, fails to explain the cause of the decreased bone matrix which is, presumably, the underlying defect in osteoporosis of the aged (1).

An attractive concept postulates a decreased bone matrix due to predominance of catabolic (or anti-anabolic) processes in aged individuals. Reifenstein and Albright (9) demonstrated in their classical studies that both estrogen and androgen therapy in osteoporosis produced decreased urinary and fecal excretion of calcium and phosphorus. Only the latter, however, induced a decreased urinary excretion of nitrogen. Pincus and associates (8) performed careful studies of the excretion of urinary steroids at various ages. Inspection of their data reveals that, past 60 years of age, all males excrete more estrogens and androgens than females; whereas the excretion of neutral reducing lipids is approximately equal.

If one assumes that urinary excretion of steroids is a reflection of endogenous levels of analagous substances, then males have more anabolic potential than females to counteract the catabolic processes and consequently better conditions for the retention of calcium and phosphorus. Therefore, over a period of many years, the female should show a greater incidence of osteoporosis than males. This is in accord with our data.

This hypothesis, however, is far from established. One of the difficulties is the assignment of precursors to the various steroid metabolites found in the urine. Valid evaluation of steroid excretion data awaits solution of this basic problem.

Our data on the incidence of back pain again raise the question of the clinical importance of this symptom and the mechanism involved. Reports of series of cases of osteoporosis cite the frequency of the presence of pain (2, 7, 9). In marked contrast are the findings of a survey study (5) in which asymptomatic vertebral fractures were found. In our series, approximately 72 per cent of the cases with significant osteoporosis (grades II-IV) were asymptomatic.

We find it difficult to accept vertebral osteoporosis as the cause of back pain. The assumption that chronic calcium loss from bone causes pain lacks adequate proof. Since most aged persons are in negative calcium balance, they should all have back pain. This certainly does not conform with clinical experience. If it is maintained that pain arises only after advanced changes in the vertebral bodies have occurred, it is not possible to explain the asymptomatic wedging and fractures found in osteoporosis. The disappearance of pain under hormonal therapy is not necessarily due to its effect on calcium and protein metabolism. It is not unlikely that the non-specific effects of steroids on mood (such as sense of well-being) is the mechanism involved.

The absence of stress and strain, which is a potent osteoblastic stimulator, permits the normal osteoclastic activity to predominate, resulting in osteoporosis. Young individuals, immobilized by extensive plaster casts, show marked hypercalciuria (6). One is therefore tempted to assume that disuse is an important factor in the pathogenesis of osteoporosis of the aged because of the decreased physical activity characterizing this group. Our data, however, do not appear to support this view, since approximately 72 per cent of the patients with significant osteoporosis were ambulatory. It will be noted, however, that in the bed-ridden category the percentage of grade II-IV cases is more than four times that of the 0 + I grades. To decide whether this is due to disuse or to the metabolic consequences of the degenerative diseases which confined the patient to bed, is not presently possible.

SUMMARY

An investigation was made of the incidence and degree of osteoporosis in 565 institutionalized old subjects. The incidence of radiographic osteoporosis was found to be higher in females than males in all age groups over 65 years; the incidence increases markedly with age, in females, but remains stationary in males. The state of ambulation is only indistinctly related to degree of osteoporosis. The following show no correlation with the degree of osteoporosis; incidence of back pain; body weight; hemoglobin, blood calcium, phosphorus, alkaline and acid phosphatase, sugar, urea nitrogen, total protein, albumin, and globulin; thyroid uptake of radio-iodine I^{131} (54 cases); fasting serum vitamin A levels and vitamin A tolerance tests (5 cases).

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A NEW TRANQUILIZING SOPORIFIC FOR INSOMNIA

The Value and Safety of Methapyrilene and Scopolamine in Combination

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In a clinical study of insomnia, a combination of methapyrilene hydrochloride with scopolamine hydrobromide† both in small dosage proved to be as effective in inducing sleep as the maximum safe dose of phenobarbital (0.1 Gm.). The methapyrilene-scopolamine combination is non-habituating and was found to be notably free from hangover and serious side reactions. It proved to be a safe medication for elderly persons, who are the main sufferers from insomnia.

Each tablet contained the following active ingredients:

Methapyrilene hydrochloride	25 mg.
Scopolamine hydrobromide	0.125 mg.

The dosage administered was 2 tablets half an hour before retiring.

The absence of untoward effects is readily explained by the small dosage of the methapyrilene-scopolamine combination, which proved effective as a somnifacient. The *United States Pharmacopeia* (9) recommends methapyrilene hydrochloride as an antihistaminic in a daily dosage up to 200 mg. The *United States Dispensatory* (8) gives the usual oral dose of scopolamine hydrobromide as 0.5 mg., to be repeated once after 4 hours if necessary.

As to therapeutic effect, there would seem to be a synergistic association between methapyrilene hydrochloride and scopolamine hydrobromide.

Methapyrilene Hydrochloride

Methapyrilene hydrochloride is an antihistaminic drug which is widely used in the treatment of bronchial asthma, hay fever, and other allergic diseases. It was during the course of such therapy that the undesired reaction of drowsiness was discovered. In some cases motorists fell asleep at the wheel.

When taken before retiring, methapyrilene provides the needed soporific effect for persons suffering from insomnia. Galambos (2) in 1955 recommended antihistaminics as substitutes for barbiturates in order to avoid the habituating and other dangerous effects of the latter drugs.

In the controlled clinical study of 54 insomniacs at the Veterans Administration Hospital, Bronx, N. Y., Straus, Eisenberg and Gennis (7) in 1955 compared the hypnotic effects of methapyrilene hydrochloride, 50 mg., and phenobarbital, 100 mg., respectively. They proved to be approximately equal. No toxic effects due to methapyrilene hydrochloride were observed.

The following statement by Straus, Eisenberg, and Gennis (7) is significant:

> The statistical validation of the hypnotic effects of the antihistamine employed in this study (methapyrilene hydrochloride) is apparent. In a dose of 50 mg. the antihistamine compares favorably with the phenobarbital in the standard dose of 0.1 gm. . . .
>
> The demonstration that an antihistamine of low order of toxicity is comparable as a hypnotic to phenobarbital in standard dosage is important. Barbiturates not only have significant toxicity but may also create dependency. Habituation to the barbiturates is common. Suicide and accidental poisoning with overdosage of barbiturates represent a significant hazard. Moreover, barbiturates may be contraindicated in the presence of liver or renal disease.

As further evidence of tranquilizing effect, Bryant (1) quieted manic psychotic patients within 24 hours by oral administration of methapyrilene hydrochloride in large dosage.

Scopolamine Hydrobromide

Scopolamine is generally recognized as a sedative and tranquilizer, when given in full dosage (0.5 mg.). Its successful use for twilight sleep is an indication of its value as a hypnotic. The present study shows that half this dosage is effective as a soporific when combined with methapyrilene hydrochloride.

The pharmacology and therapeutics of scopolamine are described by Goodman and Gilman (3) as follows:

> *Scopolamine* in therapeutic doses normally causes drowsiness, euphoria, amnesia, fatigue, and dreamless sleep. The sedative and tranquillizing effects of scopolamine have been described. . . .
>
> The *sedative* and *tranquillizing* properties of scopolamine are useful especially in patients who are rest-

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† Supplied for this investigation as Sleep-Eze tables by the Sleep-Eze Company, Inc., of Long Beach, California.

less and agitated, as in *delirium tremens, maniacal states, cardiac and hyperthyroid psychoses,* etc. Scopolamine has also been employed to obtain confessions from criminals.

According to Martin and Cook (5), scopolamine is employed for its central depressant actions as a *sedative* and *tranquilizing agent.* The *United States Dispensatory* (8) reports that scopolamine hydrobromide "is often useful in those types of insomnia in which there is motor excitement, as in delirium tremens and various maniacal states."

The following description is by Grollman (4):

> As a general rule, scopolamine produces a marked sensation of fatigue and drowsiness, the patient moves about less and speaks less, and a condition in no way dissimilar to natural sleep follows. . . . Sleep generally lasts from five to eight hours, and the patient may then remain quiet for several hours longer . . . it is of great efficacy in *insanity,* producing sound and refreshing sleep.

The Barbiturate Menace

The barbiturates provide the most dangerous abuse in sleeping pill medication. They are habit forming, toxic, and rank first of all poisonous drugs taken orally as a means of suicide.

Addiction to barbiturates is more serious than that to morphine, according to Goodman and Gilman (3). About 1500 deaths from acute barbiturate intoxication occur annually in the United States.

Life insurance statistics show that barbiturates cause 6 per cent of all suicides. In a 4-year period (1950-1953) there were 645 deaths due to barbiturate poisoning (409 suicides) in New York City and 227 (154 suicides) in San Francisco.

In my experience the use of phenobarbital and other barbiturates produces all 4 of the characteristic manifestations of drug habituation: namely, 1) abnormal pleasurable sensations, 2) tolerance (larger doses needed to produce the same effect), 3) craving for the drug, and 4) withdrawal symptoms.

With respect to tolerance, it should be noted that the effective dose must be increased with continued use, but the toxic and fatal doses remain the same. This narrowing margin of safety accounts for many of the non-suicidal barbiturate deaths.

My studies have demonstrated that a dose of methapyrilene hydrochloride (50 mg.) combined with scopolamine hydrobromide (0.25 mg.) is as effective as a somnifacient as the customary dose of phenobarbital 100 mg. As will be shown, I have also found this combination safe for treating insomnia in elderly patients, even when continued for a period as long as 3 months.

Clinical Investigation of Methapyrilene-Scopolamine

To evaluate the safety and efficacy of the methapyrilene-scopolamine combination, a group of 25 elderly insomniacs was selected, including 7 males and 18 females.

The age range was from 60 to 75, average 68. The weight range was from 92 to 192 lbs., average 144 lbs. The height range was from 61 to 71 in., average 65 in.

All patients were ambulatory, complained of insomnia, and were classified as follows:

1) *Nocturnal restlessness,* 10 cases, waking and sleeping alternately during the night.

2) *Initial insomnia,* 9 cases, inability to fall asleep after retiring, until the early hours of the morning (1 to 2 a. m.).

3) *Early morning wakefulness,* 6 cases, waking up between 2 and 4 a. m. and unable to go back to sleep.

The duration of the insomnia ranged from 1 to 12 years, average 6 years. In 14 cases the insomnia was very severe, being the problem uppermost in the patients mind. In 9 other cases the patient worried about lack of sleep. In 2 cases the insomnia was mentioned casually.

The interval before the patient fell asleep ranged from 1 to 4 hours, average 2.2 hours. The sleeping time per night ranged from 3 to 6 hours, average 4.5 hours.

In view of the current belief that scopolamine increases intraocular tension and that it may therefore be potentially dangerous to patients with glaucoma, particular attention was given to examination of the eyes in each case. An examination was made with the ophthalmoscope and with a Tyndall beam to determine lenticular opacity. Examination was also made to determine any increase in ocular tension during the period of treatment*; none was observed.

In cases where the above findings, results with an eye chart using corrective lenses, or the history warranted further examination, the patient was referred to an ophthalmologist for further study.

* Measurement of ocular tension by a tonometer was made in those cases where any increase of intraocular tension was suspected.

During the period of treatment with the methapyrilene-scopolamine combination, each patient was instructed to return for further examination and re-evaluation of his signs and symptoms at the end of each 2 weeks' period.

All 25 patients were directed to take 2 tablets (each containing methapyrilene hydrochloride 25 mg. and scopolamine hydrobromide 0.125 mg.) one-half hour before retiring. This regimen was continued, in the absence of untoward effects, for a period of 3 months.

As controls, the same patients were given substituted placebo tablets without informing them that the medication had been changed. In every case the placebo was given for a period of 1 to 2 weeks in order to control the results with the medication. If the patient complained that the treatment had become ineffective, the placebo was immediately discontinued.

During the 3 months' period of treatment with the active medication, physical examinations were repeated from time to time and, in selected cases, blood chemistry and hematology were studied and compared with the results before treatment. In every case routine and microscopic urinary examinations were performed before and during the treatment period and at some time toward the end of the 3 months. In all cases the figures for comparison were based on the results of tests taken during the last 2 weeks of a 3 months' period of medication.

Therapeutic Results

The methapyrilene-scopolamine medication improved sleep in 22 of the 25 cases (88%) and failed in 3 (12%). The placebo improved sleep in 4 cases (16%) and failed in 21 (84%).

The medication shortened the interval before falling asleep in 22 of the 25 cases (88%). The average reduction for all 25 cases was from 2.2 hours to 0.86 hour (average reduction of interval 1 hr. and 20 min.).

The duration of sleep was prolonged by the medication in 22 cases (88%). The average increase for all 25 cases was from 4.5 to 6.8 hours (average gain in sleeping time 2 hours and 18 minutes).

In my experience, sleep induced by the combination of methapyrilene hydrochloride (50 mg.) plus scopolamine hydrobromide (0.25 mg.) was as deep as that following phenobarbital (0.1 Gm.) and also more restful. There was no hangover, as in the case of the barbiturates.

Absence of Toxic Effects

Particular attention was given to the investigation of possible toxicity. In all 25 cases careful observation was made for possible development of the following toxic symptoms, in view of the scopolamine content of the medication: dizziness, blurring of vision, mydriasis, cycloplegia, photophobia, loss of light reflex, loss of accommodation reflex, dryness of throat, tachycardia, nervous disturbances, mental disturbances, sore tongue, nausea, disorientation, and delirium.

Completely absent during the entire period of observation were the following symptoms: nervous disturbances, mental disturbances, disorientation, delirium, photophobia, loss of light reflex, loss of accommodation reflex, increased intraocular tension, and tachycardia.

The only symptoms, not previously present, which developed during the period of medication, were dryness of the throat (2 cases), nausea (2 cases), and sore tongue (1 case).

Dizziness was present before treatment in 3 cases, blurring of vision in 3, mydriasis in 2, and cycloplegia in 2. In no case were these symptoms aggravated by the treatment. They were not related to the medication.

The urine analysis, routine and microscopic, remained negative in all 25 cases.

Hematologic studies showed no significant changes in blood counts or blood chemistry. Complete blood counts, hemoglobin, and differential white cell counts were included.

CASE REPORTS

Case 1. C. F., female, age 66, weight 142 lb., height 63 in., complained of severe insomnia for the last 7 years. It took her an average of 4 hours to fall asleep, with an average of 4 hours of sleep per night. This complaint was uppermost in her mind. Physical examination revealed hypertension of 6 years' duration. Investigation showed that there were no unusual stresses for her age and condition. The diagnosis was hypertension with insomnia. The patient was given placebo tablets, without her knowledge, and reported no relief of insomnia after 2 weeks. Methapyrilene-scopolamine was substituted, 2 tablets before retiring every night. There was immediate improvement, which continued throughout the 3 months' period of observation. The interval before falling asleep was reduced from an average of 4 hours to one-half hour. The duration of sleep was increased from an average of 4 hours to 7 hours. No untoward effects were observed at any time and routine urine and blood examinations were negative.

Case 2. M. B., female, age 63, weight 182 lb., height 67 inch., complained of severe insomnia with nervousness and worry for the last 4 years. It took her an average of 2 hours to fall asleep, with an average of 4

hours of sleep per night. She worried about her lack of sleep. Physical examination revealed that the patient had diabetes mellitus and spastic colitis for the last 6 years. Investigation showed that there were no unusual stresses for her age and condition. The diagnosis was diabetes mellitus, spastic colitis, and insomnia. Placebo tablets were given, without the patient's knowledge, for a period of 2 weeks. She reported no relief of insomnia. Methapyrilene-scopolamine was substituted, 2 tablets before retiring every night. There was immediate improvement, which continued throughout the 3 months' period of observation. The interval before falling asleep was reduced from an average of 2 hours to one-half hour. The duration of sleep was increased from an average of 4 hours to 8 hours. No untoward effects were observed at any time. Routine urine and blood examinations were negative. The blood sugar was 155 mg.% before the treatment and 160 mg.% at the end of the period.

SUMMARY

A dosage of methapyrilene hydrochloride (50 mg.) combined with scopolamine hydrobromide (0.25 mg.) provides an effective tranquilizing soporific for the treatment of most cases of insomnia.

In a series of 25 cases of elderly insomniacs treated with this combination for a period of 3 months, satisfactory relief was obtained in 88 per cent of cases. The same persons, serving as their own controls, were relieved by the placebo in only 16 per cent of the cases.

The medication reduced the time interval before falling asleep an average of 1 hr. and 20 min.

The medication provided an average gain in sleeping time of 2 hr. and 18 min.

A careful human toxicity study proved that the medication did not cause any of the following symptoms in any case: nervous disturbances, mental disturbances, disorientation, delirium, photophobia, loss of light reflex, loss of accommodation reflex, increased intraocular tension, tachycardia, dizziness, blurring of vision, mydriasis, or cycloplegia.

Dryness of the throat (2 cases), nausea (2 cases), and sore tongue (1 case) were observed during the period of medication.

Urine analyses, hematologic studies, and blood chemistry were negative,

The methapyrilene-scopolamine combination is as effective a somnifacient as the widely abused phenobarbital 0.1 Gm. Unlike phenobarbital, it remains fully effective in the same dose, leaves no hangover, and is completely free from habituating effects.

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American Society for the Aged Inc.

The American Society for the Aged Inc. is a voluntary non-profit organization, chartered under the Membership Corporations Law of New York State. The Society was formed to serve the following purposes:

(a) Through research to investigate or finance the investigation of all phases of age and aging.
(b) To collect and circulate information concerning the aged, and their problems, health, sociological and economic.
(c) To develop programs, in co-operation with accredited physicians and researchers, to assist the aged.
(d) To assist in the establishment, development, equipment and maintenance of hospitals, clinics, laboratories and other facilities for the aged.
(e) To develop the American Society for the Aged, a national voluntary agency, to work at all levels in the field of the aged and aging.
(f) To assist in every way possible all existing local and state agencies working in the field of the aged.

As examples of the far-reaching plans of the American Society for the Aged, one of its immediate efforts will be the construction of an isotope laboratory with the help and co-operation of scientists of the Atomic Energy Commission. A library of information on everything significant written on the problem of aging, public health and welfare is already in the process of development.

The initial effort in the starting of this library has been made possible by a grant from the William Green Memorial fund, which fund was developed by the American Federation of Labor, in memory of its long time president.

The isotope laboratory will investigate the use of the atom in studying aging processes. Modern business machines will assemble and file for quick reference all pertinent material for answering queries from any interested person or organization on the subject of aging anywhere in the world.

Because of the rapidly growing understanding of the problems of age, which understanding is being carefully studied by the Society, it is not necessary to point out the need that has existed for more and more research and study of the problems of age and aging. The sheer number of people involved, approximately eighteen million persons in this country are sixty-five years of age or over, with the consequent impact on our lives and economy, demand immediate action. Much must be done and done quickly as our aged population becomes greater every day, a staggering figure considering our total population of approximately one hundred and seventy million.

Reference, above, to the figure eighteen million persons, points up the great need there is for more statistical information on the aged. The figure of the so-called aged varies from fourteen million upwards according to the sources you investigate. The Society is taking steps in the direction of gathering statistical information on aging, and making it available to all concerned.

The American Society for the Aged is also assisting in developing and equipping and obtaining hospitals, clinics, laboratories and other facilities for the aging in all sections of the nations. The Society is also joining its efforts with all existing agencies, helping the aging on local and state levels.

The Society would like to emphasize the fact that this organization is not intended to supplant or compete with any of the existing governmental or private agencies presently operating. It is intended, however, as a national voluntary agency devoted to the aged, to act in this field as the American Cancer Society does in the field of cancer, the National Foundation for Infantile Paralysis in the field of polio, and as other great organizations in their respective fields.

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Section B

Psychological and Social Sciences, Social Welfare

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VOLUME 13, SECTION B JANUARY, 1958 NUMBER 1

METHOD-OF-APPROACH FACTORS IN THE TESTING OF MIDDLE-AGED SUBJECTS*

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Even the most carefully designed cognitive test fails to achieve unidimensionality, i.e., it invariably involves more than one dimension, in that correct solution of a problem depends not only on the subject's absolute level of ability, but also on his persistence, his accuracy and speed of work. In addition, there is some evidence of a factor, carelessness, which may intervene at some stage of the problem-solving process, and lead to the acceptance of an incorrect solution as a correct one. In any problem-solving operation, therefore, we may identify three separate classes of factor.

1) Process factors, such as memory, g, perceptual abilities, which represent the total pool of resources available to the subject;

2) Material content factors, v, n, and k, principally, which differentiate tests along the lines of words, numbers, and spatial forms;

3) Method-of-approach or temperamental factors, which derive largely from the form of the test items, and the conditions under which the tests are performed.

Method-of-approach factors such as speed, tempo, persistence, and, to a lesser extent, carefulness and accuracy, have been separated out under ordinary experimental conditions. There is a good deal of evidence for the existence of a number of speed factors—principally verbal fluency, or fluency of association (2), a motor habit (8), or speed of judgment (7) factor, and less clearly, a reaction time speed cluster (5). Tempo, natural or convenient rate or rhythm, has not been so extensively investigated, but there are indications of two strongly correlated clusters centering around writing and tapping (1). There is not a good deal of agreement between the various researches reported, but it seems justifiable to recognize group tempo factors at special levels of activity, corresponding roughly with speed factors. There is clear evidence of a common factor running through persistence tests at the ideational level, and one at the motor level (6): both are fairly general traits, and are unrelated to intelligence, particularly verbal. Neither accuracy nor carefulness can be accepted unreservedly as general, consistent traits. Although both have been identified on a number of occasions, the former in "choice" situations (4), the latter in error scores (3), the over-all evidence is quite slight.

There is some evidence (6) that the material content factors (v, n, k) cannot be measured in isolation, but range between, or are conditioned by, two work-attitude factors, persistence and speed-accuracy. Persistence seems to affect results only when the test material is difficult, while speed-accuracy affects results only when easy cognitive or unskilled motor tasks are performed. This linkage of attitude factors with the difficulty of test material poses two problems, particularly for adult testing, and in this research an attempt is made to answer these questions: 1) Do method-of-approach factors change in organization with age? and 2) Are the usual work-conditions imposed in tests optimal for older subjects?

METHODS

Sixteen tests, through which the postulated factors have been shown to operate, were selected for the test battery. These are described in table 1. Nine of the factors—carefulness, accuracy, fluency, clerical, perceptual and motor speed, and non-verbal, verbal and motor tempo were each represented by 2 tests, power and persistence factors by 3. The 16 tests thus gave a battery of 24 variables.

The battery of tests was administered in 4 sessions of approximately 1 hour each to 50 subjects, 25 men and 25 women, in the age-range 45-55. All subjects were English-speak-

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TABLE 1. THE TEST BATTERY.

Test	Content	Time-Limit (Sec.)	Scoring Formula
Matrices	Timed power	30	R
Word-building	Untimed power	UNL	R
Word-building	Verbal tempo	5	D
Word-building	Persistence	UNL	T
Incomplete words	Untimed power	UNL	R
Incomplete words	Verbal tempo	5	D
Incomplete words	Persistence	UNL	T
Number series	Non-verbal tempo	5	D
Number series	Persistence	UNL	T
Substitution	Non-verbal tempo	3	D
Checking	Carefulness	3	E
Checking	Clerical speed	3	D
Copying paragraph 2	Accuracy	4	A
Copying paragraph 2	Motor speed	4	D
3-higher	Carefulness	3	E
3-higher	Clerical speed	3	D
Measurement	Accuracy	3	A
Measurement	Motor speed	3	D
Birds	Fluency	3	D
Given letters	Fluency	3	D
Identical pictures	Perceptual speed	3	D
Figure grouping	Perceptual speed	3	D
Copying paragraph 1	Motor tempo	4	D
Copying letter H	Motor tempo	4 - 30-sec. periods	D

UNL—Unlimited.
R—Number and quality of responses; D—distance covered in time-limit; T—total time taken; A—scored for accuracy; E—error scored.

ing, and gainfully employed at the time of testing. The ability range in the sample, judging from Matrices scores, was about normal. Groups of roughly 8 subjects were retained as far as possible and tests were administered to all subjects in the same order.

Scoring procedures varied considerably. Power tests were scored for quality and number of responses. Persistence was scored as the total time the subject was willing to spend on a difficult or unpleasant task when more attractive alternatives were available. Carefulness tests were error scored—number right minus the number wrong—and accuracy was taken as the ratio of the number of errors committed to the distance covered within time-limit. Both speed and tempo were assessed as the amount of material covered within time-limit where the material was sufficiently easy for there to be practically no possibility of error. Great care had to be exercised when giving tempo test instructions to avoid introducing the suggestion that speed was desired. These tests, therefore, were administered in the initial sessions before any mental set toward speed had been established.

The fore-exercises and practice examples proved to be most important, particularly in the case of the speed tests. Here the slightest hesitation or lack of understanding of what the test demanded could affect the score considerably. Progress with practice items was carefully scrutinized, and where undue difficulty was experienced, one or two examples were worked over with the group.

RESULTS

Analysis of the Data

Five centroid factors were extracted from the 24 × 24 correlation matrix. Extractions were continued until the product of the two highest centroid loadings (0.18) was not appreciably greater than the standard error of the original correlation between the two variables (0.14).

There is no generally recognized criterion of significance applicable to factors extracted from a matrix of unknown rank. However, there are a number of criteria available (9) and these were applied to the 5 factors extracted from the experimental matrix. Factors 1, 2, and 3 are certainly significant, factor 4 marginally so; factor 5 was retained to allow greater rotational freedom.

Normal rotation procedures were followed. Eleven graphic 2 × 2 rotations were necessary to stabilize the factors in the rotated matrix. In the initial rotations, factor 4 showed heavy loadings on variables 2, 3, and 4, word-building power, verbal tempo, and persistence, while 4

TABLE 2. CORRELATION MATRIX.

1.	( )																						
2.	478	( )																					
3.	315	849	( )																				
4.	−405	168	875	( )																			
5.	−121	414	147	207	( )																		
6.	004	263	323	−108	384	( )																	
7.	091	−134	−125	168	379	−138	( )																
8.	453	409	466	073	530	504	125	( )															
9.	091	060	−108	297	366	035	401	116	( )														
10.	203	457	547	121	280	379	−043	634	004	( )													
11.	108	082	185	078	315	159	034	262	267	168	( )												
12.	293	357	375	−047	293	332	−008	448	−185	392	−002	( )											
13.	257	163	108	134	289	069	267	267	086	056	146	138	( )										
14.	294	500	366	461	379	263	−082	595	082	461	155	435	280	( )									
15.	332	474	487	034	431	418	−052	388	−009	474	284	315	414	371	( )								
16.	392	569	560	−069	371	422	147	539	−138	397	297	500	168	405	638	( )							
17.	392	461	401	−103	375	293	−103	332	233	328	250	073	246	375	504	315	( )						
18.	302	431	358	000	216	401	−306	465	−207	336	091	388	159	340	259	431	349	( )					
19.	353	470	453	065	474	466	078	457	276	418	168	125	280	474	315	375	534	401	( )				
20.	328	582	552	−095	534	530	151	496	211	379	259	267	362	345	431	478	379	328	556	( )			
21.	168	409	332	069	−121	223	−414	190	−177	375	−009	134	047	353	147	237	159	392	103	310	( )		
22.	319	504	358	297	108	315	052	396	151	284	090	−004	224	384	341	319	332	293	440	409	384	( )	
23.	207	491	323	293	263	297	−004	289	−065	504	181	267	220	759	384	358	237	228	397	336	310	315	( )
24.	284	198	241	108	177	207	009	284	−103	474	000	293	284	573	263	142	185	151	164	155	263	194	612	( )

loadings only on the remaining 21 variables approached significance. The factor had to be regarded more or less as a specific to that test (word-building), and it was decided to rotate without these variables in the battery. The final rotations, therefore, utilized a 21 × 21 matrix.

Tables 2, 3, 4, and 5 present the original correlation matrix, the raw factor loadings, the complete list of rotations, and the rotated factor loadings, respectively.

Interpretation of the factors

FACTOR 1. PERSISTENCE.

Test No.	*Name*	*Content*	*Loading*
7.	Incomplete words	Persistence	0.70
9.	Number series	Persistence	0.64
5.	Incomplete words	Power	0.64
13.	Copying paragraph 2	Accuracy	0.30
20.	Given letters	Fluency	0.28
19.	Birds	Fluency	0.26
21.	Identical pictures	Perceptual speed	−0.48

The factor enters into most untimed tests in the battery. The two tests with highest loadings were chosen originally as persistence tests and it is apparent that the factor involves time

TABLE 3. THE RAW FACTOR LOADINGS.

Test	Content	K_1	K_2	K_3	K_4	K_5
1. Matrices	Timed power	45	12	−28	21	−41
2. Word-building	Untimed power	75	−20	15	39	02
3. Word-building	Verbal tempo	73	−39	32	32	45
4. Word-building	Persistence	28	49	76	−34	20
5. Incomplete words	Untimed power	57	41	20	−31	34
6. Incomplete words	Verbal tempo	52	10	−19	15	24
7. Incomplete words	Persistence	07	45	38	−39	−08
8. Number series	Non-verbal tempo	74	11	−17	−11	16
9. Number series	Persistence	16	43	43	−19	−18
10. Substitution	Non-verbal tempo	65	−19	−21	−10	13
11. Checking	Carefulness	31	27	−04	−08	10
12. Checking	Clerical speed	45	−11	−30	−09	29
13. Copying paragraph 2	Accuracy	40	22	06	−11	−19
14. Copying paragraph 2	Motor speed	74	−30	−11	−35	−20
15. 3—higher	Carefulness	65	16	−18	08	11
16. 3—higher	Clerical speed	67	10	−25	17	28
17. Measurement	Accuracy	56	22	−08	24	−16
18. Measurement	Motor speed	50	−13	−28	24	12
19. Birds	Fluency	66	20	09	15	−15
20. Given letters	Fluency	70	28	10	26	03
21. Identical pictures	Perceptual speed	34	−47	−18	30	−10
22. Figure grouping	Perceptual speed	55	−05	15	25	−27
23. Copying paragraph 1	Motor tempo	64	−33	−12	−25	−23
24. Copying letter H	Motor tempo	46	−30	−21	−35	−27

TABLE 4. THE COMPLETE LIST OF ROTATIONS.

Rotation	Factors	Angle	
1	3, 1	18°30″	to maximize persistence in 6, leaves 7;
2	6, 4	34°00″	to maximize persistence in 8, leaves 9;
3	8, 2	45°00″	to maximize persistence in 10, leaves 11;
4	10, 5	10°05″	*Final Persistence* in 12, leaves 13;
5	11, 7	34°00″	to maximize motor speed in 14, leaves 15;
6	14, 9	34°00″	to maximize motor speed in 16, leaves 17;
7	16, 13	29°55″	*Final motor speed and tempo* in 18, leaves 19;
8	17, 15	45°00″	to maximize maintained abiuity in 20, leaves 21;
9	20, 19	45°00″	*Tentative maintained ability* in 22, leaves 23;
10	21, 23	26°00″	*Final Factor 4 in* 24, leaves 25;
11	22, 25		*Final maintained ability* in 26, leaves 27, *Final Factor 5*.

spent voluntarily on fatiguing tasks. It seems to have some identity with Alexander's X factor, a temperament or attitude-to-work factor; it affects results, however, only when the material is difficult, and is absent from tests incorporating easy material administered under speed conditions. Persistence accounts for 9.8 per cent of the total variance.

FACTOR 2. MOTOR SPEED AND TEMPO.

Test No.	*Name*	*Content*	*Loading*
14.	Copying paragraph 2	Motor speed	0.82
23.	Copying paragraph 1	Motor tempo	0.74
24.	Copying letter H	Motor tempo	0.73
10.	Substitution	Non-verbal tempo	0.45
8.	Number series	Non-verbal tempo	0.38
1.	Matrices	Timed power	0.37
19.	Birds	Fluency	0.28
21.	Identical pictures	Perceptual speed	0.28
13.	Copying paragraph 2	Accuracy	0.28
12.	Checking	Clerical speed	0.27
22.	Figure grouping	Perceptual speed	0.27

Factor 2 is identified largely in terms of motor speed and tempo and non-verbal tempo, although it is displayed through almost all speed and tempo tests—of 13 such tests in the battery, 11 have significant or marginally significant loadings on the factor. It loads exclusively on tests incorporating easy material administered at speed.

Motor speed and tempo accounts for 13.5 per cent of the total variance.

FACTOR 3. MAINTAINED ABILITY.

Test No.	*Name*	*Content*	*Loading*
20.	Given letters	Fluency	0.75
19.	Birds	Fluency	0.63
16.	3-higher	Clerical speed	0.62
17.	Measurement	Accuracy	0.57
22.	Figure grouping	Perceptual speed	0.57
15.	3-higher	Carefulness	0.54
18.	Measurement	Motor speed	0.51
6.	Incomplete words	Verbal tempo	0.48
8.	Number series	Non-verbal tempo	0.46
12.	Checking	Clerical speed	0.44
10.	Substitution	Non-verbal tempo	0.43
21.	Identical pictures	Perceptual speed	0.40
1.	Matrices	Timed power	0.34
14.	Copying paragraph 2	Motor speed	0.33
5.	Incomplete words	Untimed power	0.33

TABLE 5. THE ROTATED FACTOR MATRIX.

Test	Content	K_1	K_2	K_3	K_4	K_5
1. Matrices	Timed power	−07	37	34	25	30
5. Incomplete words	Untimed power	64	10	33	29	−47
6. Incomplete words	Verbal tempo	01	11	48	34	−18
7. Incomplete words	Persistence	70	00	−12	01	−13
8. Number series	Non-verbal tempo	17	38	46	36	−30
9. Number series	Persistence	64	01	08	−08	07
10. Substitution	Non-verbal tempo	−08	45	43	21	−33
11. Checking	Carefulness	25	08	21	29	−11
12. Checking	Clerical speed	−13	27	44	33	−36
13. Copying paragraph 2	Accuracy	30	28	25	09	06
14. Copying paragraph 2	Motor speed	01	82	33	00	−23
15. 3—higher	Carefulness	10	26	54	36	−14
16. 3—higher	Clerical speed	−01	17	62	41	−22
17. Measurement	Accuracy	11	17	57	22	18
18. Measurement	Motor speed	−24	21	51	23	−10
19. Birds	Fluency	26	28	63	13	09
20. Given letters	Fluency	28	10	75	20	00
21. Identical pictures	Perceptual speed	−48	28	40	−14	06
22. Figure grouping	Perceptual speed	05	27	57	−15	18
23. Copying paragraph 1	Motor tempo	−08	74	20	01	−14
24. Copying letter H	Motor tempo	−10	73	09	01	−10
Average variances		9.8%	13.5%	19.2%	5.4%	4.5%

This factor, with average variance 19.2 per cent, obviously cannot be called g, since it loads significantly on power, accuracy and carefulness as well as speed and tempo tests. The factor is identified as maintained ability, i.e., whether older subjects are still speedy in clerical work and non-verbal reasoning or have begun to deteriorate. Speed tests could be expected to load highly on such a factor.

Factors 4 and 5, with average variances 5.4 per cent and 4.5 per cent respectively, are obscure and indeterminate. The variances are too slight to allow positive identification of these factors with any degree of confidence.

DISCUSSION

From the rotated matrix, it is judged that simple structure requirements have been largely met, although the factor variances are probably more uneven than is usually found in such solutions. Persistence, motor speed, and tempo seem the most clear-cut of the factors isolated, and may be regarded as independent—they involve little cognitive ability and are clearly orthogonal.

These findings provide confirmation of previous results obtained in a sample of 15- and 16-year-old children (6). There is, however, one minor difference. With the older group, the temperamental factors, particularly speed, seem to operate through more embracing material and to stand out more definitely than with the younger group. With the latter, it proved impossible to differentiate motor speed and tempo from the inverse of carefulness and accuracy. In the present case motor speed and tempo stands out as a distinct factor, and most of the variance of the carefulness and accuracy tests is accounted for by maintained ability. It is doubtful whether accuracy and carefulness factors sufficiently strong to maintain independent hyperplanes could be isolated through further more detailed analysis.

As in the previous study, the temperament factors seem to be linked with the difficulty or ease of test material, with persistence operating at high difficulty levels, motor speed and tempo at easy levels. The content factors, therefore, cannot be measured in isolation, but are conditioned by these two work-attitude factors.

Clearly, work-habit components must be taken into account when time-limits are being established in testing. This probably applies less to children, since formal schooling quite early encourages development of a speed set. Where this occurs, timed and untimed tests give equally representative measures of the content factors. Since speed of work is not unduly weighted in most adult occupations, however, work-habit components should largely determine time limitations in adult tests.

SUMMARY

In this research, which is an extension of a previous study with a younger sample, the nature of speed, tempo, persistence, carefulness, and accuracy factors was investigated by factorizing 24 tests among 50 subjects aged 45-55 years. Three clearly identifiable factors, persistence, motor speed and tempo, and maintained ability, and two unidentifiable factors emerged from the analysis. The temperament factors, persistence, motor speed and tempo, stand out more clearly in this than in the younger group, and operate through more embracing material, but, as before, are closely associated with the difficulty of test material. It is suggested that the operation of content factors like g, v, or n depends considerably on these work-attitude components and that only under optimal work-habit conditions will accurate assessment of content factors be possible. This seems to have important implications for adult testing.

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A COMPARATIVE STUDY OF ELDERLY MENTAL HOSPITAL PATIENTS AND RESIDENTS OF HOMES FOR THE AGED*

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Currently in Canada at least 1 in every 6 patients admitted to a mental hospital for the first time is 65 years of age or over. In the United States the proportion is even higher. This situation is an expression of the disquieting fact that in both countries the rate of first admission at the upper ages has increased far above the rate at any other age.

Since the psychoses of old age have readily observable anatomic brain changes, the early concept was developed that this alone would explain the observed mental derangements. It was subsequently discovered that these anatomic findings are not limited to psychotic elderly people but may be found also in the non-psychotic. This led to the search for other factors of etiologic significance. The opinion that social and psychologic factors alter the resistance of elderly people to even organic mental illness has been expressed by Hollis (3), Rothchild (5), Allen (1), Williams and associates (8) and others.

Taking an epidemiologic approach, we and others have tried to identify some of these factors through studies of the first admission rate. Some progress has been made, but any analysis of rates derived for the general population is restricted in two ways. First, for practical reasons it cannot be extended beyond an assessment of census variables. Second, the influence of a variable upon the rate at which people become mentally-ill cannot easily be distinguished from an influence upon the rate at which mentally-ill people are hospitalized.

It was in order to be free of the first of these restrictions and at least less confined by the second that in this study, elderly mental hospital patients were compared, not with the general population, but with residents of homes for the aged. The specific aim of the comparison was to identify from among a wide range of variables any that do more to influence the rate of first admission than simply alter the general demand for the institutional care of elderly people. Moreover, this approach has been taken by at least one other investigator, Silverman (6), whose findings will be referred to later.

METHOD

The Sample

Hospitals and Homes for the Aged Involved—Two mental hospitals and two homes for the aged were involved in the study. The hospitals were the Ontario Hospitals at London and St. Thomas. The homes for the aged, both located in London, were the Dearness Home for Elder Citizens and the McCormick Home for Aged People.

Opened in 1954, the Dearness Home is a public institution run by the city. The McCormick Home has been operated, throughout its many years of service, on a non-profit basis by the Women's Christian Association of London.

Patients and Residents Involved—The mental hospital patients studied had all been first admitted at age 65 or over and during the years 1950 to 1952. For these patients, all needed data had already been collected during our study of population-based rates.

The residents of homes for the aged with whom the patients were compared had also all been admitted at age 65 or over. They could not, however, be exactly equated with the patients in terms of year of admission, since the Dearness Home was not opened before 1954. Another reason was related to the way in which the data from both homes were obtained. Basic information was obtained from the files of the homes. But because of the scope of the study, further information had to be provided by the residents themselves. The study was therefore confined to those in residence between June,

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Without the cooperation of the Superintendents of the Ontario Hospitals, London and St. Thomas, the McCormick Home for Aged People, the Dearness Home for Elder Citizens, and of the residents who granted interviews, this study could not have been carried out. We wish to acknowledge also the work of Dr. Edgar Love, who, as a medical student, conducted many of the interviews, and Mrs. P. Filer, who assisted with the statistical analysis.

1955, and June, 1956, when the data were collected. Thus, to obtain a workable sample no restrictions as to time of admission could be imposed.

Residents were nevertheless at least roughly equated with patients in terms of this variable. Only those admitted before June, 1956, were studied, and life expectancy after age 65 had limited the number of long-standing residents at the McCormick Home. Bias in terms of year of admission was therefore negligible.

To examine another possible source of bias, financial and residential requirements for admission to the hospitals and homes were compared. Financial requirements were found to be uniformly few. The homes, like the hospitals, were admitting indigent people as well as people able to pay their way.

Residential requirements, on the other hand, were found to differ in an effective way. At that time the Dearness Home, unlike the hospitals and the McCormick Home, admitted only people who had been living in London, a city of about 100,000, for at least a year. Bias in terms of residential background was thereby introduced.

Reduction of the bias was achieved by confining the study to patients and residents who for not less than a year before admission had been living in an urban area of at least 30,000 population. Fortunately, most of the McCormick Home residents and a workable number of the patients qualified. In all, 247 residents and 153 patients remained available for study.

Data Assembled

Items of information, already on hand for the patients and assembled from files and through interviews for the residents, are listed below. In every instance, status refers to that on admission. The ways in which the items were categorized for analysis are shown along with the results of those analyses:

Age
Sex
Birthplace
Racial origin
Whether or not the childhood home had been broken before age 5, or between ages 5 and 16—if it had, the cause and which parent was lost.
Education
Number of siblings—position in line of birth
Number of children
Marital status—number of years with that status
Economic status
For men only, occupational status—number of years with that status
Place of residence (which by design was always a city of at least 30,000)—the time and nature of any move from a smaller place of residence
Total number of changes in municipality, whether or not changes in population-size were involved, during the preceding 10 years
Living arrangements—the time and nature of any change in arrangements during the preceding 10 years
Religion
Alcohol habits
Criminal record
State of physical health

The patients were also classified according to the diagnosis assigned on admission. There were 70 patients with senile psychosis, 62 with cerebral arteriosclerosis, and 21 with other mental disorders.

More relevant to the analysis was an assessment of the mental status of the residents of the homes for the aged. Those who had been admitted with even the earliest symptoms of a mental illness were separated from the rest. To be as certain as possible that those who remained had been symptom-free on admission, the separated group included every resident showing symptoms when the data were being collected, regardless of that resident's apparent mental state on admission.

Two mentally defective and 3 epileptic residents had to be excluded from the study. Of the 242 residents who remained, 151 were classed as having been completely free of mental symptoms on admission.

Groups Compared

The study was to center upon a comparison of the patients and symptom-free residents. Any differences in composition between the two groups were to be taken as evidence that the variables concerned influenced something more than just the general demand for the institutional care of elderly people. How it could be suspected, but not definitely concluded, that such an influence must be upon the incidence of mental illness is discussed later in this report.

Residents with symptoms (either senile deterioration or neurotic behavior) were added to the comparisons to see whether, since their state of mental health lay somewhere between that of the patients and that of the symptom-free residents, their composition in terms of differentiating variables was also intermediate.

Method of Analysis

Except for average age on retirement, comparisons were made of the way in which the patients and residents were distributed, percentage-wise, throughout categories of the variables studied. An adjustment that had to be made before a satisfactory comparison in terms of environmental change could be made is described along with the results of that comparison.

The statistical reliability of differences between the distributions of patients and symptom-free residents was determined with the Chi Square test. The application of an analysis of covariance to the difference in average age on retirement is accounted for along with the description of that difference.

RESULTS

Age and Sex Composition of Patients and Residents

Table 1 shows that 45.8 per cent of the patients but only 35.2 per cent of the residents with symptoms and 27.8 per cent of the symptom-free residents were under 75 years of age. The table also shows that 72.6 per cent of the residents with symptoms but only 52.3 per cent of the patients and 59.0 per cent of the symptom-free residents were women.

Because of these differences, age-specific and sex-specific comparisons were made throughout the analysis.

Diagnostic Composition of the Patients

Table 2 shows that of the total number of patients, 43.1 per cent were patients with senile psychosis, 32.0 per cent were patients with cerebral arteriosclerosis (C.A.S.), and the remaining 24.8 per cent were patients with other mental disorders.

With increasing age, the senile psychosis percentage increased sharply from 21.4 per cent at ages 65 to 74 to 71.4 per cent at ages 85 and over, the C.A.S. percentage decreased slightly from 34.3 per cent to 23.8 per cent, and the other disorders percentage fell precipitously from 44.3 per cent to 4.8 per cent. As a result, diagnostic-specific comparisons were made whenever the influence of a variable was found not to be the same in each age-group.

The men and women were, except at ages 65 to 74, similar in diagnostic composition.

TABLE 1. PERCENTAGE DISTRIBUTIONS BY AGE AND SEX.

	Total			Men			Women		
	P*	SF†	WS‡	P*	SF†	WS‡	P*	SF†	WS‡
Ages 65–74	45.8	27.8	35.2	22.2	13.2	11.0	23.5	14.6	24.2
Ages 75–84	40.5	55.6	41.8	19.0	20.5	12.1	21.6	35.1	29.7
Ages 85+	13.7	16.6	23.1	6.5	7.3	4.4	7.2	9.3	18.7
Total	100.0	100.0	100.1	47.7	41.0	27.5	52.3	59.0	72.6
(N)	(153)	(151)	(91)	(73)	(62)	(25)	(80)	(89)	(66)

* P = Patients.
† SF = Symptom-free residents.
‡ WS = Residents with symptoms.

TABLE 2. AGE- AND SEX-SPECIFIC PERCENTAGE DISTRIBUTIONS BY DIAGNOSIS OF THE PATIENTS.

	Total				Men				Women			
	65–74	75–84	85+	Total	65–74	75–84	85+	Total	65–74	75–84	85+	Total
Senile psychosis	21.4	58.1	71.4	43.1	11.8	58.6	70.0	38.4	30.6	57.6	72.7	47.5
Cerebral arteriosclerosis	34.3	32.3	23.8	32.0	38.2	31.0	30.0	34.2	30.6	33.3	18.2	30.0
Other diagnoses	44.3	9.7	4.8	24.8	50.0	10.3	0.0	27.4	38.8	9.1	9.1	22.5
Total	100.0	100.1	100.0	99.9	100.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(70)	(62)	(21)	(153)	(34)	(29)	(10)	(73)	(36)	(33)	(11)	(80)

TABLE 3. PERCENTAGE DISTRIBUTIONS BY NON-SIGNIFICANT VARIABLES OF PATIENTS AND SYMPTOM-FREE RESIDENTS.

Number of Siblings			Number of Children		
Number	Patients	Residents	Number	Patients	Residents
0	3.7	4.1	0	21.5	15.4
1	4.4	4.1	1	15.7	21.3
2	10.4	9.5	2	22.3	15.4
3–5	39.3	32.0	3–5	25.6	30.1
6+	42.2	50.3	6+	14.9	17.6
Total	100.0	100.0	Total	100.0	99.8
(N)	(135)	(147)	(N)	(121)	(136)

Birth Order			(Occupational Status (of the men)		
Position	Patients	Residents	Status	Patients	Residents
1	24.4	27.4	Unskilled	28.6	32.8
2	15.1	9.6	Skilled	64.3	62.3
3–5	43.7	39.0	Agriculture	7.1	4.9
6+	16.8	24.0			
Total	100.0	100.0	Total	100.0	100.0
(N)	(119)	(146)	(N)	(70)	(61)

TABLE 4. AGE- AND SEX-SPECIFIC PERCENTAGE DISTRIBUTIONS BY BIRTHPLACE.

Category	Total*			Men			Women		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Native-Born	75.7	57.0	65.9	75.3	53.2	56.0	75.9	59.6	69.7
British-, American-Born	18.4	42.4	31.9	16.4	45.2	36.0	20.3	40.4	30.3
Other Foreign-Born	5.9	0.7	2.2	8.2	1.6	8.0	3.8	0.0	0.0
Total	100.0	100.1	100.0	99.9	100.0	100.0	100.0	100.0	100.0
(N)	(152)	(151)	(91)	(73)	(62)	(25)	(79)	(89)	(66)

Category	Ages 65–74			Ages 75–84			Ages 85+		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Native-Born	71.0	61.9	56.3	75.8	51.2	65.8	90.5	68.0	81.0
British-, American-Born	20.3	35.7	37.5	19.4	48.8	34.2	9.5	32.0	19.0
Other Foreign-Born	8.7	2.4	6.3	4.8	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.1	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(69)	(42)	(32)	(62)	(84)	(38)	(21)	(25)	(21)

* P-SF Difference significant at 1% level.
† Patients.
‡ Symptom-free residents.
§ Residents with symptoms.

Variables not Assessed

Because the necessary information was incomplete and, in some instances apparently unreliable, the following variables were not assessed: racial origin; economic status; number of changes in municipality; religion; alcoholic habits; criminal record; state of physical health.

Statistically Non-Significant Variables

In terms of the following variables, categorized as indicated in brackets, patients and symptom-free residents did not differ to a statistically significant degree:

1) Number of siblings (none, 1, 2, 3-5, 6+)
2) Position in line of birth (1, 2, 3-5, 6+)
3) Number of children among those ever married (none, 1, 2, 3-5, 6+)
4) Occupational status of the men (unskilled, skilled —including professional and managerial, agricultural; pre-retirement status counted)

The percentage distributions of the patients and symptom-free residents are shown in table 3. Here and in other tables any differences between the numbers shown and the total number of patients or residents represent unknowns.

Statistically Significant Variables

The patients and symptom-free residents differed to a statistically significant degree in terms of 7 variables. From the tables indicated, these differences, along with the position of the residents with symptoms, are summarized below.

Statistical significance applies, with certainty, only to over-all differences. Any described interaction of a variable with age, sex or diagnosis must therefore be regarded as tentative.

Birthplace (native-born, British- and American-born, other foreign-born)—Table 4 shows that 42.4 per cent of the symptom-free residents but only 18.4 per cent of the patients had been born in either the United States or British Isles. The deficit was made up by higher percentages of both native-born patients (75.7 per cent as compared with 57.0 per cent of the residents) and foreign-born patients from countries other than Britain or the United States (5.9 per cent as compared with 0.7 per cent of the residents).

With increasing age, the British- and American-born patient deficit grew. Moreover at ages 85 and over, it was made up entirely by an excessive proportion of native-born patients.

Table 5 provides no clear evidence that the patient-resident differences increased with age because they were more a product of senile and C.A.S. patients than of patients with other disorders.

Percentages for residents with symptoms generally fell between those for the patients and those for the symptom-free residents.

Education (illiterate; reads and writes; elementary; secondary; university; other—training not covered by preceding categories, e.g., normal school, nursing school) —Table 6 shows that only 2.6 per cent of the symptom-free residents but 7.1 per cent of the patients had no formal education, and 13.2 per cent of the residents but only 2.9 per cent of the patients had obtained further training of one kind or another in addition to their formal schooling. As reflected by differing percentages without formal education, at least, the tendency for the patients to be not as well educated as the residents was more a characteristic of the men than of the women.

Percentages for the residents with symptoms generally fell between those for the patients and those for the symptom-free residents.

Broken Home (not broken or broken after age 16, broken before age 5, broken between ages 5 and 16)—Table 7 shows that 33.1 per cent of the symptom-free residents but only 16.9 per cent of the patients had experienced a broken home before the age of 16. Moreover, 12.8 per cent of the residents but only 5.9 per cent of the patients had had the experience before the age of 5.

Of the residents with symptoms, 31.4 per cent had come from a broken home. The group was therefore more like the symptom-free residents than like the patients in this regard.

A comparison of how the homes of the patients and residents had been broken did not proceed beyond the discovery that for 91.3 per cent of the patients and for 90.0 per cent of the residents, death of a parent had been the cause.

Marital Status (single, married, widowed, divorced, or separated)—Table 8 shows that only 9.3 per cent of

TABLE 5. AGE-SPECIFIC PERCENTAGE DISTRIBUTIONS BY BIRTHPLACE OF SENILE, CEREBRAL ARTERIOSCLEROSIS, AND OTHER DIAGNOSTIC GROUPS OF PATIENTS.

Category	Ages 65-74			Ages 75-84			Ages 85+		
	Senile	C. A. S.	Other	Senile	C. A. S.	Other	Senile	C. A. S.	Other
Native-Born	86.7	70.8	63.3	77.8	75.0	66.7	86.7	100.0	100.0
British-, American-Born	0.0	16.7	33.3	19.4	20.0	16.7	13.3	0.0	0.0
Other Foreign-Born	13.3	12.5	3.3	2.8	5.0	16.7	0.0	0.0	0.0
Total	100.0	100.0	99.9	100.0	100.0	100.1	100.0	100.0	100.0
(N)	(15)	(24)	(30)	(36)	(20)	(6)	(15)	(5)	(1)

TABLE 6. AGE- AND SEX-SPECIFIC PERCENTAGE DISTRIBUTIONS BY EDUCATION.

Category	Total*			Men			Women		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Illiterate	2.1	1.3	1.1	3.1	1.6	4.0	1.3	1.1	0.0
Reads, Writes	5.0	1.3	2.2	7.7	0.0	4.0	2.7	2.2	1.5
Elementary	71.4	66.9	74.7	64.6	69.4	72.0	77.3	65.2	75.8
Secondary	16.4	16.6	9.9	18.5	12.9	4.0	14.7	19.1	12.1
University	2.1	0.7	2.2	3.1	1.6	8.0	1.3	0.0	0.0
Other	2.9	13.2	9.9	3.1	14.5	8.0	2.7	12.4	10.6
Total	99.9	100.0	100.0	100.1	100.0	100.0	100.0	100.0	100.0
N)	(140)	(151)	(91)	(65)	(62)	(25)	(75)	(69)	(66)

Category	Ages 65–74			Ages 75–84			Ages 85+		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Illiterate	1.4	0.0	0.0	1.8	2.4	0.0	6.3	0.0	4.8
Reads, Writes	5.7	2.4	6.3	5.6	1.2	0.0	0.0	0.0	0.0
Elementary	74.3	64.3	62.5	66.7	61.9	73.7	75.0	88.0	95.2
Secondary	12.9	14.3	15.6	22.2	22.6	10.5	12.5	0.0	0.0
University	1.4	2.4	3.1	1.8	0.0	2.6	6.3	0.0	0.0
Other	4.3	16.7	12.5	1.8	11.9	13.2	0.0	12.0	0.0
Total	100.0	100.1	100.0	99.9	100.0	100.0	100.1	100.0	100.0
(N)	(70)	(42)	(32)	(54)	(84)	(38)	(16)	(25)	(21)

* P-SF Difference significant at 1% level.
† Patients.
‡ Symptom-free residents.
§ Residents with symptoms.

TABLE 7. AGE- AND SEX-SPECIFIC PERCENTAGE DISTRIBUTIONS BY BROKEN HOME.

Category	Total*			Men			Women		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Broken before age 5	5.9	12.8	10.1	3.2	11.7	12.5	8.2	13.6	9.1
Broken before age 16	16.9	33.1	31.4	14.3	35.0	37.5	19.2	31.8	30.3
Not broken before age 16	83.1	66.9	68.6	85.7	65.0	62.5	80.8	68.2	69.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(136)	(148)	(90)	(63)	(60)	(24)	(73)	(88)	(66)

Category	Ages 65–74			Ages 75–84			Ages 85+		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Broken before age 5	9.7	14.6	16.1	0.0	13.4	2.6	10.0	8.0	14.3
Broken before age 16	22.6	39.0	35.5	13.0	34.1	28.9	10.0	20.0	33.3
Not broken before age 16	77.4	61.0	64.5	87.0	65.9	71.1	90.0	80.0	66.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(62)	(41)	(31)	(54)	(82)	(38)	(20)	(25)	(21)

* P-SF Difference significant at 1% level.
† Patients.
‡ Symptom-free residents.
§ Residents with symptoms.

TABLE 8. AGE- AND SEX-SPECIFIC PERCENTAGE DISTRIBUTIONS BY MARITAL STATUS.

Category	Total*			Men			Women		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Single	19.1	9.3	22.0	16.7	3.2	24.0	21.3	13.5	21.2
Married	32.9	18.5	13.2	43.1	24.2	16.0	23.8	14.6	12.1
Widowed	41.4	60.3	56.0	31.9	64.5	48.0	50.0	57.3	59.1
Divorced, Separated	6.6	11.9	8.8	8.3	8.1	12.0	5.0	14.6	7.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.1	100.0	100.0
(N)	(152)	(151)	(91)	(72)	(62)	(25)	(80)	(89)	(66)

Category	Ages 65–74			Ages 75–84			Ages 85+		
	P†	SF‡	WS§	P†	SF†	WS§	P†	SF‡	WS§
Single	21.4	2.4	25.0	21.3	10.7	18.4	4.8	16.0	23.8
Married	42.9	23.8	12.5	26.2	15.5	10.5	19.0	20.0	19.0
Widowed	31.4	47.6	46.9	44.3	65.5	63.2	66.7	64.0	57.1
Widowed, Separated	4.3	26.2	15.6	8.2	8.3	7.9	9.5	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9
(N)	(70)	(42)	(32)	(61)	(84)	(38)	(21)	(25)	(21)

* P-SF Difference significant at 1% level.
† Patients.
‡ Symptom-free residents.
§ Residents with symptoms.

TABLE 9. AGE-SPECIFIC PERCENTAGE DISTRIBUTIONS BY MARITAL STATUS OF SENILE, C.A.S., AND OTHER DIAGNOSTIC GROUPS OF PATIENTS.

Category	Ages 65–74			Ages 75–84			Ages 85+		
	Senile	C. A. S.	Other	Senile	C. A. S.	Other	Senile	C. A. S.	Other
Single	20.0	25.0	19.4	22.2	20.0	20.0	0.0	20.0	0.0
Married	40.0	45.8	41.9	19.4	30.0	60.0	20.0	20.0	0.0
Widowed	40.0	20.8	35.5	50.0	40.0	20.0	66.7	60.0	100.0
Divorced, Separated	0.0	8.3	3.2	8.3	10.0	0.0	13.3	0.0	0.0
Total	100.0	99.9	100.0	99.9	100.0	100.0	100.0	100.0	100.0
(N)	(15)	(24)	(31)	(36)	(20)	(5)	(15)	(5)	(1)

the symptom-free residents, but 19.1 per cent of the patients were single. The difference was shared by the sexes but was greater for the men than for the women. It was greater at ages 65 to 74 than at ages 75 to 84 and was reversed at ages 85 and over.

Married people were also more common among the patients (32.9 per cent) than among the residents (18.5 per cent) and again the difference was greater for the men than for the women and absent at ages 85 and over.

Only 41.4 per cent of the patients but 60.3 per cent of the symptom-free residents were widowed, (a percentage difference existing only in the case of the men), and only 6.6 per cent of the patients but 11.9 per cent of the symptom-free residents were divorced or separated (a percentage difference existing only in the case of the women) (table 8). Both of these patient deficits were most pronounced at ages 65 to 74. At ages 75 and over, in fact, the percentage of divorced or separated patients was in excess.

Table 9 shows that, although the difference decreased with age, the variation of the patients from the residents in marital composition was in no way confined to patients with "other" mental disorders.

Among the male residents with symptoms, the proportion of single persons was even higher than among the male patients, and among both male and female residents, the proportion married was lower. Widowed and divorced and separated percentages generally fell between those for the patients and those for the symptom-free residents.

Living Arrangements (living with spouse, with parent(s), with children, with others, alone)—Table 10 shows that, in naturally close agreement with the percentages of married patients and symptom-free residents, 27.0 per cent of the patients and 15.2 per cent

of the residents were living with their spouses. However, 44.4 per cent of the residents and only 16.4 per cent of the patients lived alone.

When compared on a sex-specific basis, the distribution of the residents with symptoms was closer to that of the symptom-free residents than to that of the patients.

Environmental Change—From another of our studies (2) had come evidence that the experience, after the age of 40, of more than one of three changes—a move to a different-sized municipality, a change in living arrangements and, among men, retirement—can hasten the onset of mental illness later in life. To uncover any evidence that such combined environmental changes can more directly precipitate an illness, a comparison was made of their prevalence among patients and symptom-free residents.

Not counted among the patients were changes that had taken place after the onset of mental symptoms—changes that might have been initiated in excessive numbers by those symptoms, and which, at any rate, could not have been of any etiologic significance.

Having imposed this limitation upon the period during which changes for the patients were to be counted, the usual method of equating patients and residents in terms of age on admission would have given the residents, as a group, a longer exposure to the risk of change. Instead, the age-on-admission composition of residents was balanced with the age-at-onset composition of patients.

Using 2-year age-groups, the residents were tabulated according to age on admission, and the patients according to age at onset. Then, in each age-group, equal numbers of residents and patients were obtained by removing any excess number of patients or residents strictly at random.

This balancing procedure, carried out for men and women separately, left for comparison 94 residents and 94 patients.

The results of the comparison of patients and symptom-free residents are shown in table 11. For both men and women, multiple environmental changes were actually *less* common among the patients than among the residents.

Average Age on Retirement among the Men—As with environmental change, among the patients retirement after the onset of symptoms was not counted, because of its necessary lack of etiologic significance. For a similar reason, retirement coincident with onset was excluded. Thus, to be included, retirement must have taken place at least a year before onset among the patients and, as a parallel condition, a year before admission among the symptom-free residents.

Bias was therefore again introduced. Age on retirement would naturally be to some extent correlated with whatever upper age limit was imposed, and that limit would, on the average, be higher a year before admission among the residents than it would a year before onset among the patients.

Patients and residents could have been balanced as they had been for the comparison of environmental change. However, this procedure depletes a sample and, since only the men were being compared, loss of numbers could not be afforded. Instead, average ages

TABLE 10. AGE- AND SEX-SPECIFIC PERCENTAGE DISTRIBUTIONS BY LIVING ARRANGEMENTS

Category	Total*			Men			Women		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Living with spouse	27.0	15.2	12.1	37.5	17.7	12.0	17.5	13.5	12.1
Living with children	20.4	19.2	9.9	18.1	17.7	16.0	22.5	20.2	7.6
Living with others	36.2	21.2	30.8	27.8	14.5	28.0	43.8	25.8	31.8
Living alone	16.4	44.4	47.3	16.7	50.0	44.0	16.3	40.4	48.5
Total	100.0	100.0	100.1	100.1	99.9	100.0	100.1	99.9	100.0
(N)	(152)	(151)	(91)	(72)	(62)	(25)	(80)	(89)	(66)

Category	Ages 65–74			Ages 75–84			Ages 85+		
	P†	SF‡	WS§	P†	SF‡	WS§	P†	SF‡	WS§
Living with spouse	35.7	21.4	9.4	21.3	10.7	10.5	14.3	20.0	19.0
Living with children	15.7	16.7	6.3	24.6	20.2	13.2	23.8	20.0	9.5
Living with others	32.9	9.5	40.6	39.3	27.4	23.7	38.1	20.0	28.6
Living alone	15.7	52.4	43.8	14.8	41.7	52.6	23.8	40.0	42.9
Total	100.0	100.0	100.1	100.0	100.0	100.0	100.0	100.0	100.0
(N)	(70)	(42)	(32)	(61)	(84)	(38)	(21)	(25)	(21)

* P-SF Difference significant at 1% level.
† Patients.
‡ Symptom-free residents.
§ Residents with symptoms.

TABLE 11. SEX-SPECIFIC DISTRIBUTIONS BY MULTIPLE ENVIRONMENTAL CHANGES* OF PATIENTS AND SYMPTOM-FREE RESIDENTS.

Category	Men†		Women‡	
	Patients	Residents	Patients	Residents
No or 1 change	51.3	20.5	83.6	65.5
More than 1 change	48.7	79.5	16.4	34.5
Total	100.0	100.0	100.0	100.0
(N)	(39)	(39)	(55)	(55)

* Changes counted: Change in living arrangements.
Change in size of municipality.
For men, retirement.
† Difference significant at 1% level.
‡ Difference significant at 5% level.

of retirement were computed for the groups as they stood, and then, through an analysis of covariance, the difference between those averages was assessed with the bias component eliminated.

The mean ages of retirement, uncorrected for bias, were 65.3 years for the patients and 70.6 years for the residents. As shown in table 12., analysis of covariance indicated that a significant difference persisted when the bias was eliminated.

An average for the residents with symptoms could not be obtained because it was seldom known when those symptoms had begun.

DISCUSSION

The purpose of this study was to discover if there are any differences between the social and economic backgrounds of elderly mental hospital patients and residents of homes for the aged. Any such differences were to be taken as evidence that the variables concerned either influence the incidence of mental illness or have their influence upon the demand for institutional care altered by mental illness. Whether one rather than the other situation pertains cannot, of course, be determined with certainty.

TABLE 12. RESULTS OF ANALYSIS OF COVARIANCE ON AGE OF RETIREMENT, CONTROLLING FOR AGE OF ONSET/ADMISSION.

Source	d.f.	Sum of Squares of Retirement Age (Age of Onset/Admission Eliminated)	Mean Square	Variance Ratio
Between Groups	1	376.60	376.6	7.86*
Within Groups	73	3496.47	47.9	
Total	74	3873.07		

* $p. < 0.01$.

Nevertheless, it seems likely that any variation in the demand for institutional care should be less among the mentally-ill because of their more urgent need of protection. Thus the interpretation of differences as evidence of a real effect of the variables upon incidence does not seem unreasonable. Fairly direct evidence of that kind has just been described in the case of 4 variables; birthplace, education, marital status, and age at retirement.

Three of the 4 variables, education, birthplace, and marital status are known to be associated with the mental hospital first admission rate. For example, it was found in an earlier study (7) that among the elderly patients from which the present sample was drawn, the following socio-economic segments were overrepresented in comparison with the general population: 1) the segment not educated beyond grade eight, 2) the native-born segment (in contrast to the younger patients), and 3) the non-married segment—the single, widowed, divorced, and separated.

When compared with the distribution of symptom-free residents, the percentage of patients with limited education and the percentage of native-born patients were again in excess. The influence of these variables was therefore stronger among the patients than among the residents, an indication that perhaps the variables are in some way associated with the incidence of mental illness.

The ratio of the percentage widowed, divorced, and separated to the percentage married was not as high for the patients as for the residents. However, the ratio of the percentage single to the percentage married was, on an over-all basis, at least as high, and for men, and at ages 65 to 74, even higher. Therefore, the higher first admission rate for the single cannot be as readily ascribed to a greater demand for institutional care as can the higher rate for the widowed, divorced, and separated.

The difference in the fourth variable, the earlier age of retirement among patients than among residents, is in conformity with the general suspicion that retirement and mental health may be related.

Although it is often thought that social isolation may have a detrimental effect upon mental health, we found that a greater proportion of residents than of patients had been living alone. The possibility that this difference might reflect the special need for assistance in the home

by the mentally-ill prior to their admission to hospital was discounted by the fact that recent changes in living arrangements were no commoner among the patients than among the residents.

Further, whatever effect a broken home background may have earlier in life, there is certainly no evidence from the present study that it influences mental health in old age. The percentage of elderly patients with such a background was exceptionally low, far lower, in fact, than several estimates for the general population (4).

And finally, since multiple environmental changes were commoner among the residents than among the patients, there is reason to believe that any effect they may have upon mental health is overshadowed by their effect upon the demand for institutional care.

In short, the study pointed mainly to three factors which may have a detrimental effect upon the mental health of elderly people: 1) a limited education, 2) a failure to marry, and 3) early retirement. It could be argued that each of these variables represents selection for lack of physical and mental fitness rather than an etiologic factor in the usual sense.

The importance of two of these factors was not confirmed by another investigator taking a similar approach. In a study already cited, Silverman (6), compared 24 mental hospital patients with, among other groups, 24 residents of Salvation Army homes for the aged in England. No more of these patients than residents had retired early and fewer patients than residents were single. Education was a variable which Silverman did not assess.

Two more comments about the results of the present study should be made. First, as a result of the need for age- and sex-specific comparisons, the apparent interaction of certain variables with age and sex came to light. However, most of these interactions lacked statistical reliability and few encouraged any explanation. Neither of the two interactions with age seemed to occur because patient-resident differences were the product of any particular diagnostic group.

Second, for most of the variables studied, the position of the residents with symptoms tended to be intermediate between that of the patients and symptom-free residents. This tendency was heartening because without it the validity of the observed differences would have been in serious doubt.

SUMMARY

A comparison has been made of the socio-economic backgrounds of 153 mental hospital patients and 151 residents of homes for the aged in the city of London, Canada. All persons were over the age of 65 on admission to the institutions. The patients differed from the residents of homes for the aged in the following ways: lower educational level, higher ratio of single to married, lower ratio of widowed to married, more native-born, retired at an earlier age, lived alone less frequently before admission, came less frequently from a home broken during childhood, experienced less frequently multiple environmental changes after age 40.

The patients and residents did not differ in the following characteristics: number of siblings, birth order, number of children, occupational status.

The applications of these findings to the epidemiology of mental illness among the elderly have been discussed.

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THE PROJECTION OF PERSONAL SYMPTOM INTO STEREOTYPE ABOUT AGING

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Previous studies on attitudes toward aging have shown that individuals differing in age, education, and life experience subscribe substantially to the misconceptions and stereotypes about old people and the older worker (2, 3, 4, 5, 6, 7, 8). Since most people tend to believe that physical and mental decline are necessary concomitants of the aging process, the individual may begin to think of himself as old when he sees physical changes in himself as he grows older, e.g., graying hair, loss of teeth, difficulty in seeing or hearing. It is these physical changes which he has learned to accept as evidence of "oldness" in others. When an individual accepts these signs of aging as the bases of identifying himself *old*, he may begin to worry, to feel insecure, and to believe that his best years are behind him. The perception of physical changes leads to psychologic responses of anxiety, frustration, and stress. These perceptions are likely to be reinforced with greater and greater frequency, leading inevitably to his increasing acceptance of the cultural stereotypes about aging.

The purpose of this study is to obtain an estimate of the relationship between physical and psychologic changes, reported by the individual as either bodily, or as mood and feeling symptoms, and the number of stereotypes he accepts about old people and the older worker. The hypothesis to be tested suggests that the greater the number of symptoms an individual has the greater the number of stereotypes he accepts.

MATERIAL AND METHODS

Reports of bodily and of mood and feeling symptoms were obtained through the use of the Cornell Medical Index (1), a self-administered paper-and-pencil inventory of 195 questions requiring a "yes" or "no" response. One hundred forty-four questions of the Index refer to bodily symptoms, e.g., "Do you need glasses to read?," "Do you constantly suffer from bad constipation?;" the other 51 questions refer to mood and feeling symptoms, e.g., "Are your feelings easily hurt?," "Do people often annoy and irritate you?"

Acceptance of stereotypes about aging was obtained by questionnaires which also required a "yes" or "no" response to specific statements. The first questionnaire consists of 137 statements about old people, covering broad categories, e.g., physical decline, mental deterioration, conservatism, family relationships, activities, and interests. The second questionnaire consists of 51 statements about the older worker, in broad categories, e.g., attitudes toward the job, interpersonal relationships, and mental decline. Except for the relatively few statements about physical changes with age (which are supported by research evidence), the overwhelming majority in both questionnaires are unproved, i.e., they must be considered as misconceptions and stereotypes about the abilities, skills, and personality of old people and the older worker.

The relation between symptom and stereotype was studied in two samples: a younger and an older group. The younger sample was composed of 394 graduate students (192 men and 202 women) at Teachers College, Columbia University; the older sample was made up of 87 people (38 men and 49 women), some living in an institution for the aged and some living in their own homes but attending recreational day centers for older people in New York City. The average age and standard deviation in years were 32.3 and 6.7 for the male students, 32.5 and 8.9 for the female students, 74.4 and 7.2 for the older men, and 74.5 and 5.0 for the older women.

RESULTS

The number of accepted stereotypes about old people and about the older worker each was correlated with the number of reported bodily symptoms and also with the number of reported mood and feeling symptoms on the Cornell Medical Index. These are shown in table 1. The correlations between symptoms and stereo-

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TABLE 1. MEAN AND STANDARD DEVIATION FOR BODILY, AND MOOD AND FEELING SYMPTOMS ON THE CORNELL MEDICAL INDEX; FOR STEREOTYES ABOUT OLD PEOPLE AND ABOUT THE OLDER WORKER; AND CORRELATION BETWEEN SYMPTOMS AND STEREOTYPES; FOR 192 MALE GRADUATE STUDENTS, 202 FEMALE GRADUATE STUDENTS, 38 OLDER MEN, AND 49 OLDER WOMEN.

Group	1 Bodily Symptoms		2 Mood and Feeling Symptoms		3 Stereotypes about Old People		4 Stereotypes about the Older Worker		Correlation Between Groups			
	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	1 and 3	1 and 4	2 and 3	2 and 4
Male graduate students	9.5	6.8	3.4	5.0	47.4	22.3	10.9	9.0	.22**	.15*	.27**	.19**
Female graduate students	11.6	7.8	4.4	5.3	50.9	23.1	13.0	9.7	.28**	.30**	.19**	.17*
Older men	17.3	11.7	7.1	8.2	77.7	22.2	22.1	12.2	.31	.09	.19	.02
Older women	25.8	16.0	8.5	6.9	71.0	23.4	22.8	12.5	.24	.21	.33*	.48**

* Significant at .05 level.
** Significant at .01 level.

types, in every instance, are positive, although those for the older sample are not always significantly different from zero. The data, fragile though they are, suggest there is some slight evidence that the greater the number of reported symptoms, the greater the number of accepted stereotypes. The average of all the correlations between symptoms and stereotypes is .23, which may suggest response set as a source for the correlations, i.e., the correlations may be due to the tendency for some subjects to report yes's and others to report no's.

If projection of personal symptom into stereotype were indicated more than response set, a higher correlation would be expected between reported bodily symptoms and accepted stereotypes about physical changes than between reported bodily symptoms and accepted stereotypes about other aspects of aging; and that a higher correlation would be expected between reported mood and feeling symptoms and accepted stereotypes about emotional aspects of aging than between reported mood and feeling symptoms and accepted stereotypes about other areas. The stereotypes about old people were classified into 13 categories and the stereotypes about the older worker into 9 categories. For this report, however, only categories with 5 or more stereotypes were utilized.

For the Old People questionnaire, the 10 categories considered were: Physical, Activities and Interests, Financial, Family, Personality Traits, Insecurity, Mental Deterioration, Conservatism, Attitudes Toward Future, and Best Time of Life. For the Older Worker questionnaire, the 6 categories were: Physical, Mental, Interpersonal, Keeping Youth Down, Employer Attitudes—Costs, and Waiting for Retirement. In general, for each of the 4 groups, the correlation between reported bodily symptoms and accepted stereotypes in the Physical category in each questionnaire is higher than the average correlation between reported bodily symptoms and accepted stereotypes in other categories about aging; the average correlation between mood and feeling symptoms and categories dealing with emotional components (Personality Traits, Insecurity, and Mental Deterioration from the Old People questionnaire; and the Mental and Interpersonal categories from the Older Worker questionnaire) is higher than that between mood and feeling symptoms and accepted stereotypes in other categories. The difference between the correlations, although small, is in the direction of expectations in 14* of the 16 comparisons. For the 4 groups combined, on the Old People questionnaire the average correlation is .28 between bodily symptoms and the Physical category and .17 between bodily symptoms and other categories; on the Older Worker questionnaire, the average correlations are .23 and .15, respectively. On the Old People questionnaire, the average correlation is .21 between mood and feeling symptoms and the categories dealing with emotional components and .16 between mood and feeling symptoms and other categories; on the Older Worker questionnaire, the average correlations are .18 and .14 respectively.

Comparison of the reported specific symptoms with the analogous stereotypes also sug-

* Using the sign test, the difference is significant at the .01 level.

TABLE 2. PROPORTION OF ACCEPTANCE OF STEREOTYPE FOR SUBJECTS REPORTING THE SYMPTOM AND FOR THOSE WHO DO NOT.

Cornell Medical Index	Stereotypes about old people	Younger Sample						Older Sample					
		Yes C* n	Yes S† n	Yes C* n	No S† n	No C* n	No S† n	YY YY+YN %	NY NN+NY %	Yes C* n	Yes S† n	Yes C* n	No S† n	No C* n	No S† n	YY YY+YN %	YN NN+NY %
Do you need glasses to read?	Old people need glasses to read.	105	77	114	106	58	52	71	7	7	1	91	88
Are you easily upset and irritated?	They get upset easily.	18	30	107	238	38	31	17	7	44	18	71	71
Does worrying continually get you down?	They worry about unimportant things.	11	11	145	224	50	39	15	4	41	27	79	60
Do you often cry?	They are easily moved to tears.	5	10	93	285	33	25	8	2	41	36	80	53
Do you often have small accidents or injuries?	They have many accidents in the home.	5	7	111	266	42	29	16	6	27	36	73	43
Do cold hands or feet trouble you even in hot weather?	They feel cold even in warm weather.	8	8	109	267	50	29	12	5	33	33	71	50
Are you hard of hearing?	They are hard of hearing.	8	6	126	250	57	36	14	0	48	22	100	69
Do you have to be on guard even with your friends?	They are suspicious of others.	10	16	66	301	38	18	5	5	32	48	50	40
Does life look entirely hopeless?	They think the future is hopeless.	3	2	35	334	60	9	5	6	27	44	45	38
Do you wear yourself out worrying about your health?	They worry about their health.	1	2	227	163	33	58	9	1	56	23	90	71
Are you considered a touchy person?	They are touchy.	12	14	122	244	46	33	21	3	40	22	88	65
Have you lost more than half your teeth?	They have lost most of their teeth.	15	17	274	102	88	73	67	5	11	2	93	85
Do you constar t'y suffer from bad constipation?	They suffer from constipation.	14	10	116	247	58	32	23	0	37	26	100	59
Are you frequently confined to bed by illness?	They spend much time in bed because of illness.	0	2	52	339	0	13	4	0	38	44	100	46
Does working tire you out com- ı letely?	They feel tired most of the time.	15	17	104	256	47	29	15	5	37	29	75	56
Are you always miserable and blue?	They feel miserable most of the time.	1	2	30	361	33	8	5	3	27	50	63	35

* Cornell Medical Index.
† Stereotypes about old people.

gests projection more than response set. On the Cornell Medical Index, there were 16 symptom questions about which there were related statements in the questionnaires about stereotypes, e.g., "Do you need glasses to read?" on the Index and "Old people need glasses to read" on the questionnaire about stereotypes; "Are you easily upset and irritated?" on the Index and "They get upset easily" on the questionnaire about stereotypes. The comparison of reported symptom and stereotype, given in table 2, shows that the proportion of acceptance of the stereotype is higher for subjects reporting the symptom than for those who do not. For the younger sample, this is evident in 14* of the 16 questions; for the older sample it is evident for 15* of the 16 questions.

DISCUSSION

The small relation between symptoms and stereotypes may be due to the fact that the number of reported symptoms may not be an adequate index of the physical and psychologic changes within the individual, for reported

* Using the sign test, the difference is significant at the .01 level.

symptoms, by the Cornell Medical Index, do not account for 3 factors which may influence attitude toward aging. These are: 1) Recency of the symptoms. For instance, a "yes" response to the question, "Do you need glasses to read?" may have a greater affect if the respondent was fitted with bifocals recently than if he had worn glasses since early childhood. Yet, each reported symptom is considered equivalent regardless of circumstances; 2) Severity of the symptoms. A "yes" to the question "Are you crippled with severe rheumatism (arthritis)?" may have more relevance to the respondent's feelings about aging than a "yes" to the question, "Is your skin very sensitive or tender?"; 3) Management of the symptoms. Two individuals may report identical symptoms even of a severe nature, but one may not be able to function at all while the other may be able to do so with a minimum readjustment in his regular pattern of living.

Despite the possibility that response set may account for the relation between symptoms and stereotypes, the evidence does indicate acceptance of stereotypes as a function of reported symptoms. The tendency for those who have the disability to believe that it is generally true of the class of old people and older workers is operating against response set and against the tendency of people to accept stereotypes about aging in general.

SUMMARY

The purpose of this study was to estimate the relationship between physical and psychologic changes, reported by the individual as either bodily, or as mood and feeling, symptoms and the number of stereotypes he accepts about old people and the older worker. The hypothesis to be tested suggested that the greater the number of symptoms an individual has the greater the number of stereotypes he accepts.

The relation between symptom and stereotype was studied in two samples: a younger group of 394 graduate students; and an older group of 87 institutionalized and noninstitutionalized adults.

The correlations between symptoms and stereotypes, in every instance, were positive, although those for the older sample were not always significantly different from zero. The average of all the correlations between symptoms and stereotypes was .23, which may suggest response set as a source for the correlations, i.e., the correlations may be due to the tendency for some subjects to report yes's and others to report no's.

However, a higher correlation was found between bodily symptoms and accepted stereotypes about physical changes than between bodily symptoms and other stereotypes about aging, and between mood and feeling symptoms and accepted stereotypes about emotional aspects of aging than between the same symptoms and other stereotypes. Also, a comparison of specific symptoms with the analagous stereotypes showed that the proportion of acceptance of the stereotype was higher for subjects reporting the symptom than for those who did not. These findings suggest that acceptance of stereotypes is a function of reported symptoms. The tendency for those who have the disability to believe that it is generally true of the class of old people and of older workers is operating against response set and against the tendency of people to accept stereotypes about aging in general.

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AGE DIFFERENCES IN WORK ATTITUDES*

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In the index of many books on vocational and industrial psychology no mention of the age factor is found. This surprising fact is called to our attention by Pressey and Kuhlen (12, p. 262). This does not mean, however, that psychologists have completely neglected the age factor. For example, in the most recent (1957) edition of the *Annual Review of Psychology*, Katzell (4) in the section on Industrial Psychology, includes a number of industrial studies where the age factor plays a role (5, 11, 14, 16). Of these, the study by Vollmer and Kinney (16) is the most related to the present investigation; they conclude that older employees and the uneducated have a higher level of job satisfaction. In his comprehensive volume on *Motivation and Morale in Industry*, Viteles (15) names a number of studies that are concerned with seniority as well as age in his chapter on The Assessment of Employee Morale. In his volume on *Human Factors in Air Transportation*, McFarland (6) gives a full consideration of aging and its effects on efficiency in airmen.

More recently there is concern with the older worker and the kind of work that is available for him. The most comprehensive study of this kind, a completely statistical approach (2), concerns the survival rates in old age for 32 occupations as found in the census studies in England. Its purpose is to be a survey of modern industry from the viewpoint of its oldest operators; that is, it is an attempt to see what workers are physically able to continue in the various occupations beyond the mid-sixties.

The purpose of the present study is to help fill in the area of needed knowledge regarding the age factor in vocational and industrial psychology. Also, a correlated purpose is to replace stereotypes of the aged by exploring and recording actual people in real situations at a defined time.

PROBLEMS, METHODS, AND SOURCE MATERIALS

The specific questions considered in the present investigation include the following: What are the chief age differences in the sources of satisfaction and dissatisfaction in a given work situation? Are there distinguishing features which characterize each age group? What are the significant differences between the age groups in the various areas of satisfaction studied? What, for example, are the differential age patterns in attitudes toward work conditions, pay, benefits, supervision, policies, and management?

For obtaining answers to these questions a variety of ways was used: a) results of morale survey data obtained in 1956, b) behavior records available about such people surveyed—facts concerning absenteeism, turnover, accidents, and other events in a worker's daily life, and c) interviews with select people, as well as records of interviews over long periods for all of the workers available in the Personnel Office of the company studied. The present study is concerned largely with the problem of age differences in opinions, impressions, and perceptions.

Setting and Population Structure

The factory in which this study was made is located in the industrial north side of St. Louis. Its population, however, does not come entirely from the north side because the company originally was located in the south side and some of its older workers have continued to come to work, regardless of distance. Workers from Illinois represent a smaller proportion. Their social and economic ways have certain differences which do affect work attitudes.

To understand the differences that show up in the older age group it is necessary to realize that the workers were hired when the plant was very small and the few managers at that time were of a rough and ready nature. When the plant was moved these people took some of the habits obtained from training in the atmosphere which existed on the south side to the north side where, as the plant grew more organized, firm and democratic procedures characterized management's pattern of organization. Some of the characteristics in behavior patterning in the plant have been previously reported (7, 8, 9).

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For the purposes of this study the subjects were divided into 4 groups as follows: Group I—composed of 103 workers, or 40%, aged up to 30; Group II—composed of 98 workers, or 38%, with an age range from 30 to 45; Group III—43 workers, or 17%, with an age range from 45 to 60; and Group IV—13 workers, or 5%, all over 60. The reliability of the differences between the small number in Group IV and the other groups can, on the face of it, be legitimately questioned. It should be remembered that the critical ratio procedure for calculating reliability of differences is specifically aimed at correcting for small groups. Even more important is the fact that the 13 individuals in this group were all interviewed individually, and the findings of the interviews, as well as the statistical results, show a consistency in their group which warrants the conclusion that in the industrial setting studied, the larger group would take on similar characteristic attitude differences.

Some of the early results indicated seeming discrepancies which could not be explained in terms of age groupings only. The 45 to 60 group particularly seemed to have two conflicting patterns of attitudes within it. It was decided to investigate the geographic distribution to determine if background could be a contributing factor in this change, which it turned out to be.

A geographic distribution of the population by age groups was determined, but for brevity will not be reported here. It is enough for the present purpose to say that whereas the percentage of population living in the south side of the city in Group I was 13.6% in Group II, 11.2%, and in Group IV, 15.4%, the ratio in Group III was 41.9%.

All of the employees in the company in 1956 were studied. The plant was composed of 5 production departments, 4 service departments, a laboratory and research department, and 3 offices—Production, Cost, and Sales. There were more older people in 3 of the departments, and it was these same departments that had more of the mixed population from both the south and north sides in their staffs. Interestingly enough these departments included some of the most skilled as well as some of the least skilled. The kind of people who moved with the plant, to a larger extent, included the very skilled people and the very unskilled ones. The company is known by its workers and others in the area as being one of the few companies in the United States that has never had a layoff in its 35 year history. The plant is managed so that employment stabilization is one of the features planned for in the direction of sales and merchandising as well as in production problems.

Age Differences in Sources of Satisfaction and Dissatisfaction

Information containing the sources of work satisfaction and dissatisfaction was based on a morale survey composed of 40 items. Only 36 of the items were used in this particular study. Omitted from consideration here are the kind of items in which it is impossible to say which direction is satisfaction or dissatisfaction for morale or production. In this study the work satisfaction index was calculated for each item and is so recorded. Since morale in general terms is not what we were studying at that time, a work satisfaction index was determined for each particular item. The questions asked are indicated in brief form in table 1. Each question had 5 choices, including 2 above average and 2 below average. The work satisfaction index for each item in each age group was determined by subtracting the percentage of the 2 which were below average satisfaction from the percentage of the 2 which were above average satisfaction. This follows the procedure used in determining the algedonic difference in the study of individual differences in forgetting pleasant and unpleasant experiences (10). In this case the formula for determining work satisfaction is $S/T - U/T$, the S representing the percentage above average satisfaction and the U the percentage below average satisfaction. The middle choice is not included in the calculations. The index is thus a measure of the predominance of satisfaction over dissatisfaction. All of the work indices for each age group are presented in table 1.

Direction and Significance of Age Differences

For the 36 questions with 4 different age groups, there would be 6 comparisons within the age groups; that is, 6 t tests, for a total of 216 t tests. At .05 chance expectancy this would yield 11 significant differences. From the data reported in table 1, 46 such differences were actually obtained. All of the differences between every age group on every item and every other age group on every item were calculated

and the critical ratios for each determined. All of these are available, but for purposes of brevity, only the statistically significant differences between the youngest and the oldest and the group with 45 as the dividing line are reported.

RESULTS

In the differences between Groups I and II, the 2 younger groups, there are 8 that are significant, 5 at .05 level of confidence and 3 at .01 level of confidence. In the differences between Groups I and III, there are 11 significant differences, 6 at .05 level and 5 at .01 level. In the differences between Groups I and IV, the oldest and the youngest, there are 10 statistically significant differences, 7 at .05 level and 3 at .01 level. In the differences between Groups II and III, those just below 45 and those just above 45, there are 7 statistically significant differences, 6 at .05 level and 1 at .01 level. In the differences between Groups II and IV there are only 4 differences that are statistically significant, 2 at .05 level and 2 at .01 level. Between Groups III and IV, the 2 oldest groups, there are, however, 6 statistically significant differences, 2 at .05 level and 4 at .01 level.

Of the 10 differences between Groups I and IV, the oldest and the youngest groups, the 7 differences at .05 level of confidence are: 1) as place to work, 5) suggestions encouraged, 7) can tell how good job am doing, 15) supervisor's interest in you, 17) company policies made clear, 27) share of happiness, and 28) share of recognition. The 3 at the .01 level of confidence are: 6) chances for advance, 19) company pay scale, and 31) stock purchase.

Of the 7 differences between Groups II and

TABLE 1. AGE DIFFERENCES IN SOURCES OF SATISFACTION AND DISSATISFACTION.

Question	Rank Within Age Group					Index			
	Total	I	II	III	IV	I	II	III	IV
1. As place to work	7	16	4	4	1.5	68.6	83.2	79.1	100.0
2. Work well Planned	5.5	10	13	2	11.5	74.5	74.4	81.4	76.9
3. Co-workers	1	2	7	7	3	89.2	80.5	76.7	92.3
4. Supplies on hand	10	3	11	13	16	84.2	76.3	69.0	69.2
5. Suggestions encouraged	20	17	19	30	31	66.7	56.2	34.1	30.7
6. Chances for advance	33	33	34	34	36	35.3	9.5	15.0	−61.7
7. Can tell how good job am doing	32	30	32	32	32.5	40.0	31.8	18.6	7.6
8. Job best qualified for	12	15	11	17	16	70.3	76.3	63.4	69.2
9. How well satisfied are most employees	18	21	17	24	21.5	61.4	66.1	45.1	61.7
10. Others are doing as much work as they can	19	12	28	26	21.5	72.7	48.6	42.9	61.7
11. Teamwork of supervisors	8	9	14	1	4	75.5	73.8	83.8	84.7
12. Training of new employees	5.5	6	6	8	11.5	79.5	81.3	74.7	76.9
13. Supervisory discipline	23	23	22	25	29	59.0	52.7	44.2	41.6
14. Favoritism by supervisor	27	31	33	33	26	38.7	29.9	16.7	53.9
15. Supervisor's interest in you	2	1	3	9.5	14	90.1	83.8	73.1	69.4
16. Supervisor's competency	4	7	1	3	5	79.3	90.2	79.2	84.6
17. Company policies made clear	10	8	9	6	1.5	76.0	77.9	78.6	100.0
18. Top management	16	20	15	11	9	61.9	71.0	72.1	77.2
19. Company pay scale	35	35	35	35	32.5	−37.5	−13.2	− 2.5	7.6
20. Job rate in line	36	36	36	36	35	−53.0	−42.7	−37.5	−41.7
21. Rate complaints handled fairly	24	24	20	27	23	58.2	55.0	42.5	61.6
22. Security on job	28	29	29	21	27	42.2	47.4	53.5	46.0
23. Vacation and holiday practices	26	26	21	20	9	52.7	54.3	35.6	77.2
24. Facilities for resting, etc	22	27	25	15	19.5	50.5	51.6	67.5	66.6
25. Credit union	10	5	5	18	13	82.1	82.2	62.5	75.1
26. House organ	3	4	2	5	9	83.5	88.4	78.7	77.2
27. Share of happiness	30	34	31	19	18	32.7	37.1	60.0	66.7
28. Share of recognition	34	22	26	20	28	60.7	51.1	53.7	45.4
29. Pension plan	29	28	30	28	30	48.3	39.1	38.1	30.9
30. Bonus	14	18	16	13	16	66.6	70.2	69.0	69.2
31. Stock purchase	31	32	24	31	34	36.4	51.7	33.2	−16.7
32. Safety program	21	19	27	23	24	63.4	48.9	50.0	61.5
33. Quality control	15	14	18	16	6	71.0	61.1	65.7	83.3
34. Housekeeping	25	25	23	22	25	56.9	52.5	51.1	58.4
35. Health and Accident Insurance	17	11	8	13	7	72.4	78.9	69.0	81.8
36. Blue Cross and Blue Shield	13	13	11	9.5	19.5	71.8	76.3	73.1	66.6
Number of firsts	36	..	..	..	..	10	9	4	13

III, the 2 middle groups with age 45 as the dividing line, the 6 differences at .05 level of confidence are: 5) suggestions encouraged, 9) how well satisfied are most employees, 23) vacation and holiday practices, 25) credit union, 27) share of happiness, and 31) stock purchase. The 1 at .01 level of confidence is 19) company pay scale.

The rank order inter-correlations among the age groups were also determined. The highest correlation is between the 2 younger groups, .91. Between the oldest group and each of the other groups the correlations are .78 with the youngest group, .84 with the next youngest group, and .87 with the next oldest group. The relationships here are directly related to age differences. The correlation between Group III and Group I is .83 and with Group II it is .86. Age groups then are correlated more closely when they are nearer each other.

Another way of obtaining a picture of the distinguishing characteristics of each age group is to compare the number and kind of items in which each age group ranks first. Out of the 36 items, Group I ranks first on 10 items, Group II ranks first on 9 items, Group III ranks first on only 4 items and Group IV ranks first on 13 items. The respective items are listed in table 1.

Age Differences in Reaction to Company Management and Policies

The question "What do you think of the company as a place to work?" has been found by the present writer, as well as others (15, Chap. 14), to be one of the best ways of obtaining the general attitude toward a company. The choices given were:

1) I would rather work here than any other place I know.
2) Much better than average place.
3) About average, the same as most others.
4) There are not many places that are worse.
5) One of the worst in the city.

How the various age groups react to the first item is indicated in table 2, which also shows that in attitude toward the company as a place to work, the older group definitely outranks any of the other groups in favorable reactions. There is an immense difference not only in the number of responses which are satisfactory, but in the intensity of reactions as well. In Group IV 76.9 are highly satisfied and 23.1 satisfied, whereas in the youngest group there are only 20.6 highly satisfied and 49.0 satisfied. Groups II and III are similar in pattern but this is one of the items in which the mixing of workers coming from the south side with those from the north side makes a difference in Group III. In terms of rank within the group, Group II and III list this item as the fourth most preferred, whereas the oldest group ranks it first and the youngest group ranks it sixteenth.

TABLE 2. REACTIONS TO COMPANY AS A PLACE TO WORK.

Satisfaction Indices		Age Groups			
		I	II	III	IV
Degree of satisfaction	Very satisfactory	20.6	48.9	41.9	76.9
	Satisfactory	49.0	35.4	39.5	23.1
	Neutral	29.4	14.6	16.3	....
	Dissatisfactory	1.0	1.1	2.3	....
	Very dissatisfactory	....	....	....	....
Satisfaction index		68.6	83.2	79.1	100.0
Rank		16	4	4	1.5
Critical ratio	II	2.39*	....	....	....
	III	1.28	.58	....	....
	IV	2.37*	1.60	1.80	....

* Significant at .05 level of confidence.

Critical ratios of the differences are also indicated in table 2. The statistically significant differences are between the oldest and the youngest and the youngest and the next youngest. The other differences are not significant although the highest trend is indicated between Group III and IV.

Since attitude toward top management and attitude toward company policies are also indicative of attitude toward the company as a whole, all 3 of these items were added and calculations made on differences in indices when these 3 items are combined. The general trend is similar in pattern to the reactions to the question about the company as a place to work. The satisfaction indices for the 4 groups are: Group I, 68.74; Group II, 77.34; Group III, 76.58; and Group IV, 92.32. The highest level of confidence is for the difference between the oldest and the youngest groups. The critical ratio here is 3.07. The next highest critical ratio (2.35) of differences found was between the 2 youngest groups, in favor of the older. The differences between Group II and IV and Groups III and IV are also statistically significant when the 3 questions are lumped, the critical ratio for both being 2.16. There are, therefore, 4 differences here that are statistically significant at a .05 level of confidence.

On attitude toward policies there is a general progressive trend in favor of the older group being higher in approving the general policies of management. Reactions to top management are less differentiating for the age groups than the reactions to policies and the company as a place to work. The reason here is probably because of the lack of clarity on the part of many workers as to which people are identified as top management. Many workers think of top management only as the President, Vice President, and other executives, whereas many other workers include the whole production planning group; that is, all of the people who are supervisors of their own foremen.

Age Differences in Areas of Work Satisfaction

For the sake of bringing out possible age differences in areas of work satisfaction rather than single items, a number of the items were classified under the larger categories of work conditions, attitude toward people, attitude toward pay and benefits. The following items were included under work conditions: 2) work well planned, 4) supplies on hand, 23) vacation and holiday practices, 24) facilities for resting, etc., 32) safety program and 34) housekeeping. Attitude toward people included 3) co-workers agreeable and cooperative; 11) team-work of supervisors, 12) training of new employees, 13) supervisory discipline, 14) favoritism by supervisor, 15) supervisor's interest in you and 16) supervisor's competency. Attitude toward pay included 19) company's scale of pay, 20) job rate in line, and 21) rate complaints handled fairly. The items included under benefits were 29) pension plan, 30) bonus, 31) stock purchase, 35) health and accident insurance, and 36) Blue Cross and Blue Shield.

Indices for each age group in each of the categories were calculated, differences obtained, and critical ratios determined. There is only one category in which there is a general progressive trend which correlated with age and that is attitude toward pay. The youngest are the least satisfied and the oldest are most satisfied with pay, the differences all being reliable at .05 level of confidence. The differences on benefits are statistically significant at .05 level of confidence between the oldest group and the youngest and the oldest and the second youngest. The other differences are not significant. On attitude toward people the only difference that is statistically significant is between Group III and Group I at .05 level of confidence.

If the similar categories are analyzed in terms of intensity, some differences show up which do not reveal themselves when differences are calculated in terms of the work satisfaction index. For example, whereas attitude toward work conditions shows no reliable differences in terms of critical ratio, on differences obtained when they are spelled out in detail in terms of the degree of satisfaction at every level running from the very satisfied to the very dissatisified, the chi-square is 23.1, which is significant at a .05 level of confidence.

Table 3 shows that the satisfaction index items indicate no reliable difference because the difference revealed here is in intensity. Similar reactions in age differences were found in attitude toward co-workers and attitude toward supervisors, as indicated in table 4. The chi-square for the differences in co-workers is 33.8, and for the supervisor category it is 28.9. Both are significant at the .01 level of confidence.

On the item, what do you think of your chances for advancement?, there is a distinct age difference in favor of the younger group and all of the differences are statistically significant at a .05 level of confidence or at a .01 level of confidence, except for the differences between the 2 middle groups.

In response to the question, Does your supervisor play favorites?, it was the oldest group that had the least criticism. Whereas the next oldest group more often than not paralleled the reaction of the oldest group, in this particular instance it was Group III which was most critical and most accusing of the supervisors playing favorites. In this case it is the youngest group that ranks second in an uncritical attitude toward supervisors, and the difference between Group I and Group III is also statistically significant at .05 level of con-

TABLE 3. INTENSITY DIFFERENCES IN ATTITUDE TOWARD WORK CONDITIONS.

Satisfaction Index	Age Group			
	I	II	III	IV
Very satisfactory	25.8	26.91	32.67	39.47
Satisfactory	48.9	43.23	37.45	36.84
Neutral	14.4	19.44	19.12	15.79
Dissatisfactory	9.8	9.03	7.97	6.58
Very dissatisfactory	1.1	1.39	2.79	1.32

TABLE 4. INTENSITY DIFFERENCES IN ATTITUDES TOWARD CO-WORKERS AND SUPERVISORS.

Satisfaction Index	Attitude Toward Co-Workers				Attitude Toward Supervisors			
	Age Group				Age Group			
	I	II	III	IV	I	II	III	IV
Very satisfactory	34.88	31.27	32.28	61.54	24.9	24.47	25.49	45.5
Satisfactory	46.18	41.58	47.80	15.38	52.8	51.60	47.84	28.6
Neutral	13.29	19.24	14.96	17.95	14.8	16.48	15.29	20.8
Dissatisfactory	4.32	5.15	8.66	5.13	5.2	5.50	7.06	5.1
Very dissatisfactory	1.33	2.76	6.30	.....	2.3	1.95	4.32	.....

fidence. The only way to explain the unique position of Group III in response to this question is to consider the population composition of the group, this being the group which has the largest number of people from the south side and which has expectancies of being favored not being realized, as they see it.

DISCUSSION

Expressed in more general terms, what do the age differences reported imply for individual adjustment or industrial management? What are the differential characteristics, in more general terms, of the elderly workers?

If one compares the differences found between the oldest and the youngest groups, some very interesting seeming paradoxes appear, as well as some clear differences. The oldest group definitely rates higher than any other age group in its identification with the company as a place to work, its management, and its policies. This is a definite strength, but in this particular company there is a fair amount of motivation involved which can only be understood in the light of the knowledge of the attention given to the various age groups in terms of experience and skill, as well as likely responses to such practices. For example, it is the oldest group of workers which gives the least favorable response to the item that they think suggestions are not encouraged. It is the youngest group that rates high on this point. Again, it is the youngest group that gives the most favorable response to being able to tell how good a job they are doing and it is the older group that gives the least favorable response on this item. It is the oldest group that thinks less of supervisory discipline; it is the youngest group that thinks best of this. It is the oldest group that is more likely to accuse the supervisors of favoritism; it is the youngest group that reports less favoritism by supervisors. At the same time the oldest group thinks of the supervisor's interest in them as being highest and also rates the teamwork of supervisors highest.

Do these seeming paradoxes, as well as clear differentiation between the youngest and oldest groups, prove Harris' (3) contention to the effect that, "An old population is more conservative, less creative, less productive, less mobile, and more dependent than the younger one."? The answer for this particular age group is that there is no such consistency. There are work attitude differences, however, that can have real implications for management working to obtain good morale from all of its age groups which it can gain by applying all of the facts observed. In this particular company the picture is not the same as the generalized conclusions of Harris (3). The induction and training given to the youngest workers are responsible for their thinking highly of their supervisors as disciplinarians and for their thinking well of them in not practicing favoritism; also for their feeling about getting their share of recognition. This then represents a pattern that goes with relatively low tenure and young age in this particular work situation and is directly related to management practices.

On the other hand, the attitude of the older workers can also be perceived as a pattern, and so perceived, the paradox seems to make sense; namely, they think well of management and its policies, they like the company as a place to work, they think well of supervisors in general, and that the supervisors are interested in them, but they consider themselves neglected in certain types of attention and are high in their feeling that supervisors play favorites and do not treat them as favorites. Their saying that they can't tell how good a job they are doing merely means that the supervisors take them for granted too much and that they would like more attention. So perceived, the fact that the oldest group gives the most favorable response to questions about having had its breaks and share of happiness, but rates itself low in share of recognition, makes unifying sense. It makes sense only, however, if the context of the situation and all that characterizes its human relations practices are considered.

The fact that it is the older group that is most satisfied with vacation and holiday prac-

tices, whereas the next oldest group definitely is the least satisfied, calls for an explanation. Three weeks' vacation after 15 years is the practice of this company, and all of Group IV have 15 or more years of service and get 3 weeks' vacation. It is the next to the youngest group that has in it many people with relatively low tenure and, since the vacation program gives preference to tenure, it is understandable that those who, for example, get 3 weeks' vacation feel more satisfied than those who do not. It is also understandable that the satisfaction index of the next group is almost half the size of the older group—a number of them do not get the longer vacation and resent it, and so on for related practices.

On facilities for resting and relaxation there is a difference between the 2 youngest and the 2 oldest groups. The satisfaction indices for the 2 younger groups are in the low fifties and for the 2 older groups in the low seventies. The chief problem here is one of attitude in terms of recreation. As the company grew and filled in its empty spaces, the room formerly available for baseball, badminton, ping-pong, and horseshoes was no longer available, and this meant more to the younger groups than to the older groups.

Almost every difference which occurs between the oldest and the youngest groups, or between other groups, can readily enough be interpreted in facts known about managerial practices, specific supervisors the workers happen to have, nature of jobs in the departments, and related factors. One thing clearly revealed in this study is that the tendency to try to search for easy generalizations about age differences can yield only an invitation to contradiction and confusion.

People, regardless of age, can only be understood in terms of all of the human surroundings as well as the jobs they do and their feelings about them. Aging in one company as compared to any other company is likely to have some different characteristics. Aging in one company may mean a spoiling process in some areas and a hard attitude and over-expectancy in other respects. What management expects from older and younger workers, but what becomes an age role factor on the part of the workers, is relatively specifically determined in the work situation by the human beings as they live, experience, and work. Their home background and cultural patterning in general, which influence their behavior at the outset, can only be modified, sometimes drastically, by the work situation.

Riesman in his *The Lonely Crowd* (13) classified people into 3 groups—the adjusted, the anomic, and the autonomous. This is one way to look at the elderly to determine what is good for them to do and what is good for management to do with them.

Of the 13 elderly people interviewed, none were anomic. Only 3 could be classified as adjusted in making the easiest adjustment to circumstances without trying to do anything about the circumstances. Ten could easily be classified as autonomous. This does not mean that 10 out of every 13 people are autonomous, but it does mean that in this particular plant at this particular time most of them were doing good jobs of interpreting life, as well as living it, and likewise doing a good job. One of them vehemently and 4 other mildly actually satisfy Anderson's (1, p. 541) criterion for living well in old age, namely: "Individuals should try to grow old not passively and gracefully, but actively and ungracefully and should use their learning capacity energetically." From this there can be only one implication, the formula that everyone should retire at 65 is ill-advised, if biologic, economic, and social factors are the basis for making a decision.

Generally speaking, what holds in a study of cultural differences in groups holds in the same way for differences in industrial settings. The reason that in psychology not enough facts are given about differences in cultural, economic, and social settings is because it is taken for granted that all of America is alike and what is found in one place will be found in the other. Psychology and psychopathology in industry cannot be understood or dealt with adequately if this style of cultural sameness characterizes the basis for generalizations implied. Social conditions and work conditions are different and different responses from human personalities are to be expected. In industry it is well to study the problems of age differences and related problems situationally and motivationally as well as departmentally and group-wise.

SUMMARY

The present study of age differences in work attitudes reports results based on an investigation of 270 workers divided into 4 age groups in one industrial setting. Source material used in-

cluded findings of a morale survey containing 36 questions, supplemented by behavior records as well as interviews.

Three important findings of a general nature are revealed in this study: 1) the emotional climate of an industrial setting which has distinctive characteristics influences the nature of work adjustments of employees of all ages, but not to the same degree; 2) there are many statistically significant differences in the 4 age groups studied; 3) there are individual differences within each age group.

More specifically considered, the study reveals 46 statistically significant differences in morale survey comparisons. These distinguishing group differences are reported in terms of satisfaction indices and also in terms of number of firsts in which each age group ranks on the 36 items. In considering the company as a place to work and items indicative of identification with management and its policies, there is a tendency for increased favorable attitude with age. Age comparisons are reported for 4 areas of work satisfaction: pay, work conditions, attitude toward co-workers, and attitude toward supervisors. Attitude toward pay in this group becomes increasingly more favorable with age. In the other 3 areas of possible work satisfaction (work conditions, attitude toward co-workers, and attitude toward supervisors) no statistically significant differences are found when the results for all degrees of satisfaction and dissatisfaction are lumped. Statistically significant differences are indicated in all 3 areas, however, when each degree of satisfaction is treated separately. The chief source of these differences is in intensity of feelings. A higher degree of satisfaction in all of these areas increases with age. The differentiating age in work conditions is 45. In attitudes toward co-workers and supervisors the largest differences found were between the oldest group and all other groups. The correlations among the age groups range from .78 to .91. The groups closer to each other correlate highest with each other. The highest correlation, (.91) is between the two younger groups, and the lowest (.78) is between the youngest and the oldest group.

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BOOK REVIEWS

PSYCHOLOGICAL DEVELOPMENT THROUGH THE LIFE SPAN, by Sidney L. Pressey and Raymond G. Kuhlen, Harper, New York, 1957, 654 pages, $6.00.

This is a text for the interested layman, teacher, trainee, or undergraduate student. It contains the expected topics: physical, mental, emotional, and social development. In addition, three chapters deserve special mention. "Education Through the Life Span" will be interesting and stimulating to anyone concerned with learning in the later years. "The Work Life" is an excellent consideration of this too-frequently neglected topic. "Changing Motivation in the Life Span" brings this basic topic out of the rat-mazes and into the realm of the activities of human beings of all ages.

The volume is unusual in that the changes which occur in maturity and old age are an integral part—indeed, are emphasized—in every chapter, instead of being tacked on the end of a book of child psychology. Thus one may look at the span and sweep of life whole rather than piecemeal.

The discussions are well (to say the least) documented. One hundred fourteen figures, 99 tables, and roughly a thousand bibliographic references seem almost overwhelming to the reader who tackles more than a chapter at a time. It is disappointing with this wealth of data to find no cumulative author index; to locate a specific study one must plod through the chapter bibliographies. Undergraduate students in this reviewer's classes complain of the chatty, wordy style. Even discounting their normal grumbling tendencies, there seems to be some justification for the complaints.

In the area of intelligence, the authors unfortunately continue to draw their inferences about ability change in middle and older years from cross-sectional studies like the classical Jones and Conrad research. While more recent, longitudinal studies are mentioned, their findings do not seem to be adequately considered.

DON C. CHARLES
Dept. of Psychology
Iowa State College

MOBILIZING RESOURCES FOR OLDER PEOPLE, Proceedings of the Federal-State Conference on Aging, June 5, 6, 7, 1956, Washington, D. C. U. S. Government Printing Office, 1957, 120 pages, (including 22 pages listing conference participants), paper bound.

This volume is a report of the Conference sponsored by the Council of State Governments and the Federal Council on Aging, attended by official state delegates appointed by the governors, state, and federal officials and invited guests.

The purpose, as stated in the introduction, was to clarify the roles of Federal and State Governments and to initiate a continuing relationship among key government officials working in the field.

The Proceedings include the principal addresses of Robert Meyner, Governor of New Jersey, outlining the responsibility of the states; Arthur Larson, then Under-Secretary of Labor, on the plight of the older worker; and Marion Folsom, Secretary of the Department of Health, Education, and Welfare, on government programs for older persons.

The working sessions of the Conference reported in the Proceedings, contain the usual divisions: 1) income maintenance and welfare; 2) employment rehabilitation and retirement; 3) physical and mental health; 4) education and recreation; 5) housing and living arrangements; but perhaps the most important division was that on State Organization and Function, for it was one of the principal hopes of the Conference that its recommendations would stimulate the formation of state organizations where such did not already exist. Many additional states—at least 7 before the publication of the report—have established such organizations. What influenced the states to take action, one cannot say, but undoubtedly, the Conference had its influence.

WILLIS H. REALS, Co-Chairman
Committee on Gerontology
Washington University, St. Louis

FINANCING HEALTH COSTS OF THE AGED, Office of the Special Assistant, Problems of the Aging. State Capitol, Albany, 1956. 239 pages, $2.00.

This is a report of a conference of 60 professional specialists convened by Governor Averell Harriman to explore ways of paying for health services for the older population, characterized by higher illness rates and lower incomes than the general population. The report contains 5 formal papers which set the problem, conclusions of 3 work groups, and numerous source tables. Among the many recommendations made by these groups were those urging extension of voluntary insurance to all older persons, spread of premiums over the working lifetime, continuation of government payments for health services to low-income persons, and coverage under the OASI program.

CLARK TIBBITTS
Assistant Director
Special Staff on Aging
U. S. Department of Health,
Education, and Welfare

BOOKS RECEIVED

A Classified Bibliography of Gerontology and Geriatrics, Supp. one—1949-1955, by Nathan W. Shock, Stanford University Press, Stanford, Calif., 1957, 525 pages, $15.00.

A New Look at the Mature Worker, Massachusetts Dept. of Labor and Industries, Division on the Employment of the Aging, Boston, 1957, 7 page folder.

Brightening the Senior Years, the 1957 report of the New York State Joint Legislative Committee on Problems of the Aging, Legislative Document No. 81, 139 pages, paper bound.

Financing Health Costs for the Aged, New York State Conference convened by Governor Averell Harriman at the State Capitol in Albany, 1956 (obtainable from the Office of the Special Assistant, Problems of the Aging, State Capitol, Albany, New York—make check or money order payable to the Commissioner of Taxation and Finance), 1957, 239 pages, $2.00 (reviewed in this issue, page 82).

How the Mature Worker Finds His Job, Massachusetts Dept. of Labor and Industries, Division on the Employment of the Aging, Boston, 1957, 8 page folder.

Job Attitudes: Review of Research and Opinion, by Frederick Herzberg, Bernard Mausner, Richard Peterson, and Dora F. Capwell, Psychological Services of Pittsburgh, Pittsburgh, 1957, 291 pages, paper bound, $7.50.

Older People and the Industrial Community, a Report of the 1957 Spring Meeting, The National Committee on the Aging of the National Social Welfare Assembly, edited by Elma Phillipson. John B. Watkins Company, New York, 1957, 46 page pamphlet $1.00.

Services for the Aging, a, Report on the Seventh Annual Southern Conference on Gerontology Held at the University of Florida, March 14-15, 1957, University of Florida Institute of Gerontology, edited by I. L. Webber, University of Florida Press, Gainesville, 1957, 159 pages, $2.50.

The Chronically Ill, by Joseph Fox, Philosophical Library, New York, 1957, 229 pages, $3.95.

The New Frontiers of Aging, edited by Wilma Donahue and Clark Tibbitts, University of Michigan Press, Ann Arbor, 1957, 209 pages, $5.00.

Trends in Gerontology, second edition, by Nathan W. Shock, Stanford University Press, Stanford, California, 1957, 214 pages, $4.50.

JOURNAL OF GERONTOLOGY

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JANUARY, 1958

Section C

Organization Section
Index to Current Periodical Literature

JOURNAL OF GERONTOLOGY

VOLUME 13, SECTION C | JANUARY, 1958 | NUMBER 1

ORGANIZATION SECTION

GERONTOLOGICAL SOCIETY, INC. COUNCIL FOR 1957

President	Albert I. Lansing (Pittsburgh)	Past President	Robert J. Havighurst (Chicago)
President-elect	Louis Kuplan (Sacramento)	Treasurer	John Esben Kirk (St. Louis)
	Secretary	Nathan W. Shock (Baltimore)	

	to serve through
Biological Sciences	
Warren Andrew (Winston-Salem)	1959
Norman M. Sulkin (Winston-Salem)	1960
Clinical Medicine	
Robert T. Monroe (Boston)	1959
Leo Gitman (Brooklyn)	1960
Psychological and Social Sciences	
Robert W. Kleemeier (Orange Park)	1959
Ethel Shanas (Chicago)	1960
Social Welfare	
Ben L. Grossman (Chicago)	1959
Jerome Kaplan (Minneapolis)	1960
General Membership Division	
Walter M. Beattie, Jr., (St. Charles, Mo.)	1958
Helen Zollinger (Portland, Ore.)	1960
Affiliate Organizations Division	
Harold E. Jones (Berkeley)	1960
Chairman, Research and Fellowships Committee	
John E. Anderson (Minneapolis)	1958

PAST PRESIDENTS OF THE SOCIETY

William DeB. MacNider	1945	Ernest W. Burgess	1952
Roy G. Hoskins	1946	E. Vincent Cowdry	1953
Lawrence K. Frank	1947	Anton J. Carlson	1954
Joseph C. Aub	1948	Ollie Randall	1955
Clive M. McCay	1949	William B. Kountz	1956
C. J. Van Slyke	1950	Robert J. Havighurst	1957
Robert A. Moore	1951		

SUMMARY OF THE MINUTES OF THE TWELFTH ANNUAL MEETING OF THE COUNCIL AND MEMBERS OF THE CORPORATION OF GERONTOLOGICAL SOCIETY, INC.*

The meeting was called to order by President R. J. Havighurst at 2:45 p. m., October 30, 1957, in Parlor 24, Hotel Cleveland, Cleveland, Ohio. Members of the Council present were: R. J. Havighurst, A. I. Lansing, N. W. Shock, J. E. Kirk, H. S. Simms, W. Andrew, A. A. Hellbaum, J. E. Birren, Florence E. Vickery, L. Kuplan, and W. M. Beattie, Jr. Members absent were: W. B. Kountz, R. T. Monroe, R. W. Kleemeier, and O. J. Kaplan.

The Minutes of the Eleventh Annual Meeting of the Council and Members of the Corporation of Gerontological Society, Inc., had been approved as corrected by a mail vote.

Dr. Kirk presented the written report of the Treasurer, pointing out that the economic status of the Society was fair, but that there would have been a deficit if a grant of $4,000.00 for 1957 had not been received from the Forest Park Foundation. He reported that the increase in dues had not affected membership in the Society, there being 1197 members receiving the Journal in 1957, 1067 in 1956, and 1028 in 1955; non-member subscriptions increased from 727 to 774. Dr. Kirk remarked that of the new members for 1957, 64 General Members have an M.D. or Ph.D. degree; 27 of the new General Members applied for Fellowship status, this figure including some without the M.D. or Ph.D. degree.

Dr. Kirk requested the Council's opinion regarding the solicitation of voluntary contributions from Fellows and Members, and it was decided by formal motion that the Society would discontinue solicitation of con-

* A full report is available upon application to the Administrative Secretary, Mrs. Marjorie Adler, 660 South Kingshighway Blvd., St. Louis 10, Missouri.

tributions for general purposes from Members, although it was agreed that the motion left the way clear to solicit funds for specific purposes from Members, other individuals, or foundations.

Dr. Simms moved that a reserve fund consisting of 50 per cent of the unexpended operating balance available December 31, 1957, be set aside and that beginning January 1, 1958, 5 per cent of the annual income from dues and subscriptions be added to this reserve fund, which could be appropriated by the Council to meet specific needs of the Society in the future. The motion carried.

Dr. Kirk presented the written report of the Editor of the Journal of Gerontology. After some discussion, the motion was made and passed that the Editor of the Journal be authorized to use his judgment in utilizing a commercial source for soliciting advertisements for the Journal. It was also decided that it is not the responsibility of the Society to raise funds for the publication of monographs or supplements to the Journal, but that if a manuscript were acceptable to the Editorial Board and the Editor and the author could provide the financing, publication might be approved.

Dr. J. T. Freeman, who was invited to be present at 6:00 p. m., gave the report of the Committee on Exhibits, saying that Journals & Exhibits, Inc., had arranged for 6 commerical exhibits at the present meeting and hoped to build this up to a considerably larger number at the Philadelphia meeting. The motion was made and carried that the Society continue present arrangements with Journals & Exhibits regarding exhibits for the 1958 meeting.

Dr. Freeman raised the question of registration fees for the 1958 meeting. The Council repealed their action at the 1956 meeting which had set a $4.00 registration fee, and the motion was then made and carried that the local committee for 1958 should have the authority to decide on ways of financing the annual meeting, with a registration fee not to exceed $4.00 if this device were employed.

Dr. Kaplan's report as Editor of the Newsletter was considered, and the motion was made and passed that the President, on behalf of the Council, should write to Dr. Kaplan, expressing appreciation for his success in building up the Newsletter.

Dr. Wilma Donahue's report of the Membership Committee was taken up, and it was agreed in principle to continue the regional structure of the Membership Committee as presently set up for the coming year. As of October 4, 1957, the total membership of the Society was 1560. There are 1220 members and Fellows, of which 120 are in arrears in dues for one year. Fellowship, by Sections, includes 166 in Biological Sciences, 364 in Clinical Medicine, 140 in Psychological and Social Sciences, and 157 in Social Welfare.

On recommendation of the appropriate committees of the various Sections, 41 candidates were elected to Fellowship in the Section on Biological Sciences, 56 in Clinical Medicine, 19 in Psychological and Social Sciences, and 9 in Social Welfare.*

Figures regarding expense and income from the sale of Fellowship certificates were presented, and it was moved and carried that the price of the certificates be set at $2.00 each.

Consideration was given to Mr. Tibbitts' report of the Nominating Committee, and the slate agreed upon (as amended at the second Council meeting) was as follows: President-elect, Mr. L. Kuplan; Secretary, Dr. N. W. Shock; Treasurer, Dr. J. E. Kirk; Council representative for Biological Sciences, Dr. N. M. Sulkin; for Clinical Medicine, Dr. L. Gitman; for Psychological and Social Sciences, Dr. Ethel Shanas; for Social Welfare, Mr. J. Kaplan; for Social Welfare to fill the unexpired term of Mr. Kuplan, Mr. B. Grossman; for the General Division, Mrs. Helen Zollinger; for the Affiliate Organizations Division, Dr. H. E. Jones. It was also agreed that the Chairman of the Research Grants and Fellowships Committee would be a member of the Council for 1958; Dr. J. E. Anderson will thus serve as a Council member for the coming year.

Dr. Andrew's report of the Committee on Constitution and Bylaws was discussed and was accepted as amended, with one negative vote. The major changes* approved were: 1) Membership, as well as Fellowship, may be held in any of the four Professional Sections of the Society, 2) the distinction between a regional or state chapter of the Society and affiliate groups is clarified, 3) Council representatives for each Section will be nominated by the Council from a list of nominees submitted by each Section, and 4) specific funds from the Society may be allocated for use by each Section in conducting its affairs.

The meeting adjourned at 9:05 p. m.

Continuation of Council Meeting—The meeting was called to order at 4:15 p. m., November 1, 1957, in Parlor 24, Hotel Cleveland, Cleveland, Ohio. Members of the Council present were the same as listed above.

On motion by Mr. Kuplan it was voted to adopt the policy in regard to membership which was presented by Dr. Havighurst:

STATEMENT ON PROCEDURES FOR MEMBERSHIP IN GERONTOLOGICAL SOCIETY, INC.

There shall be a form for application for membership in the Society which is separate from the form for application for Fellowship. The membership application form shall be sent out freely to applicants and to Members of the Society who might request them. This form shall ask for sufficient information to serve as a basis for judgment concerning the applicant's education, experience in gerontology, and interest in the field.

The form shall refer to two categories of Membership.

a.) Professional Member—a Member of one of the Professional Sections, paying dues of $12.50, which includes a subscription to the Journal of Gerontology. The applicant shall indicate which Section he wishes to join.

b.) General Member—a Member of the General Member Division, paying dues of $12.50 or $2.50 as he chooses.

Action on applications for membership shall be taken by the Secretary on the basis of criteria which he and the Membership Committee believe are adequate. The criteria may differ for membership in the Professional Sections and in the General Member Division. It is understood that all applicants of good character and definite interest in the field of gerontology shall be admitted to the General Member Division.

Uniform Fellowship criteria were passed as amended:

UNIFORM CODE OF REQUIREMENTS FOR FELLOWSHIP STATUS

1. A Member of Gerontological Society, Inc., may apply for Fellowship status to become effective after a total period of membership of at least 12 months. Suitable application forms will be supplied on request only. Each application must be endorsed with the original signatures of two Fellows, one of whom must be in the same Section as the applicant.

* The Social Welfare Section decided to review deferred applications on the basis of the stated policies on uniformity of Fellowship qualifications adopted by the Council. A mail vote was authorized by the Council to be completed by December 31, 1957.

Lists of those elected to Fellowship will be published in the April issue of the Journal of Gerontology.

* The revised Bylaws are published in full in this issue, page 90.

2. Each application will be reviewed by a committee of three in the Section to which the applicant belongs. This committee shall consist of the two current Council Members and the most recent past Council Member of that Section. If approved by a two-thirds vote of the committee, the application will be submitted for confirmation to a meeting of the Section, and then to the Council for final action. If not approved, the application may be deferred for reconsideration the following year, or it may be disapproved (in which case the applicant may reapply after one year). Any application lacking adequate information may be deferred or disapproved for this reason. A list of approved Fellows shall be presented at the next business meeting of the Society.

3. The criteria for approval of an application are as follows:

a.) The applicant must have been educated, or trained, or have had extensive experience, in some phase of gerontology related to the Section to which he, or she, belongs.

b.) The applicant should hold an appropriate professional degree. However, exception may be made for outstanding individuals who have made recognized contributions to their fields of gerontology. In such cases the requirements for higher academic degrees may be waived by the Council on presentation of facts showing exceptional merits of the applicant.

c.) The applicant must have demonstrated an active interest in gerontology and must have made some valuable contribution to gerontology or related to gerontology, as manifested by publications, or by meritorious papers presented at meetings of scientific societies, or by unpublished research, or by leadership in his, or her, respective field.

4. In cases of individuals with unusual accomplishments, the 12-month interval before granting Fellowship status may be waived by the Council on recommendation by the Fellowship Committee of the Section to which the Member belongs.

The statement on policy with regard to affiliates was also adopted:

STATEMENT OF POLICY ON AFFILIATE ORGANIZATIONS AND LOCAL CHAPTERS

The policy of the Council will be to encourage regional and state gerontological societies to become local chapters of Gerontological Society, Inc. However, it is recognized that the status of Affiliate Organizations exists and is held by two organizations, which have the right to continue in this status. In the future, the officers will attempt to work out arrangements whereby organizations applying for affiliation will become local chapters of the Society. The Society affirms the autonomy of local chapters in matters of local, state, and regional concern. The local chapters will determine the criteria for membership in their organizations but will agree that all of their officers shall be members of the Gerontological Society, Inc.

It is expected that the arrangement between the national Society and local chapters will be mutually beneficial.

It is expected that, in due time and on the basis of future experience, the categories of Affiliate Organizations and Local Chapters will become one and the same. At present the two categories will be considered as one for the purpose of selecting representatives on the Council of the Society.

A Committee to determine ways and means of increasing the circulation of the Newsletter, to define the role of the Newsletter in the publications program of the Society, and to consider the subscription price of the Newsletter was authorized. A Committee was also established to consider the categories of membership and membership fees, although not necessarily to revise them. It was agreed that this latter Committee could either be the same as the first Committee, part of the Constitution and By-laws Committee, or a separate Committee.

The report of the Finance Committee, presented by Dr. Lansing, was accepted.

The Council acknowledged, with appreciation, the grants of $4,000 from the Forest Park Foundation, $5,000 from the Glendorn Foundation in support of the symposia given at the annual meeting and publication of a supplement to the Journal, $5,000 from the National Institutes of Health in support of the work of the Sub-committee on Biology and Medicine of the Research and Fellowships Committee of the Society, and $9,448 from the National Institutes of Health that made it possible to bring the European scientists to this meeting and publish their papers. Appreciation was also expressed to the American Society for the Aged for the reception held prior to the annual dinner of the Society.

Dr. Lansing pointed out that the Society should establish a procedure for appointing a representative of Gerontological Society, Inc. to the International Association of Gerontology. It was moved and passed that when the Society's relationship with the International Association of Gerontology is regularized to the satisfaction of the President of Gerontological Society, Inc., the President is empowered by the Council to release funds for the payment of dues. It was also agreed that Gerontological Society, Inc. would pay the regular dues for each Member receiving the Journal and for each Fellow (which have been set by the International Association of Gerontology at 15 cents per member).

A contribution of $50.00 to the National Society for Medical Research was voted.

The amended budget for 1958 was accepted, with an estimated deficit of $4,400. It was voted that dues would remain as in 1957.

Dr. Lansing stated that he was opposed to holding a Pan-American Congress of Gerontology. It was voted that cooperation of Gerontological Society, Inc. with other groups scheduling meetings or conferences in 1958 or 1959 will require Council approval.

The invitation to hold the 1959 meeting in Detroit was accepted,* the meeting to be held in the middle of November and the exact dates to be set by the President, Dr. Lansing. The Council voted to hold the annual meeting in 1960 in association with the Fifth International Gerontological Congress in San Francisco. Dr. Lansing invited Gerontological Society, Inc. to hold its annual meeting in Pittsburgh in 1961.

The continued affiliation of the Western Gerontological Society and the Florida Council on Aging was approved.

An Abstract Committee, consisting of Dr. Lansing, Dr. Shock, and Dr. Verzár as members, was authorized to assist in the organization of the new Section of Abstracts in Gerontology and Geriatrics of Excerpta Medica.

The Council voted appreciation of the work of the Program Committee and the Local Arrangements Committee.

After a standing vote to the President, the meeting was adjourned at 6:10 p. m.

N. W. SHOCK, Secretary

* The 1958 meeting will be held at the Bellevue Stratford Hotel in Philadelphia, November 6-8, 1958.

SUMMARY OF THE MINUTES OF THE TENTH ANNUAL BUSINESS MEETING OF GERONTOLOGICAL SOCIETY, INC.*

The meeting was called to order by President R. J. Havighurst at 11:40 a. m., November 2, 1957, in the Ball Room of Hotel Cleveland, Cleveland, Ohio. Approximately 55 members were present.

The Minutes of the Ninth Annual Business Meeting were approved, and the actions and recommendations of the Council (see above Minutes) were reported by the President, Secretary, and Treasurer of the Society. The report of the Corporation was made available for inspection by members of the Society.

The nominees for officers and representatives on the Council presented by the Council were unanimously elected, and after discussion from the floor all actions and recommendations of the Council were approved (for details see Minutes of the Council meetings).

A unanimous vote of appreciation was given to the Program Committee and to the Local Arrangements Committee, and the meeting adjourned at 12:45 p. m.

N. W. SHOCK, Secretary

* A full report is available upon application to the Administrative Secretary, Mrs. Marjorie Adler, 660 South Kingshighway Blvd., St. Louis 10, Missouri.

SURVEY ON UNIVERSITY RESEARCH ON AGING

An inquiry was conducted in 1957 by the Sub-committee on Biology and Medicine of the Research Grants and Fellowships Committee of the Gerontological Society, Inc. (Dr. Albert I. Lansing, Chairman) on university research on aging currently being carried out in the United States. The survey was made by Dr. John E. Kirk. Six hundred ninety-three letters were sent to various university departments (Anatomy, Biochemistry, Biology, Botany, Dentistry, Medicine, Pathology, Physiology, Veterinary Medicine, and Zoology), and 208 replies were received, covering 189 subjects. The names of the universities and departments were obtained from *World of Learning*, 7th edition, Europa Publication, London, 1956; *Index Generalis*, 19th edition, Dunod, Paris, 1952-1953; and *A Complete Reference Book to 2049 American Colleges and Universities*, Simon and Schuster, New York, 1953-1954. A copy of the tabulated subjects may be borrowed by university departments, other professional institutions or members on request to the Editorial Office of the Journal of Gerontology. Financial support by the National Institutes of Health (grant H-3157) is gratefully acknowledged by the Committee.

Bylaws of Gerontological Society, Inc.

Adopted November 2, 1957

Article I

Section 1. *Offices.* The principal offices of the Corporation shall be located in the City, County, and State of New York.

The Society may maintain such other offices in such place or places within or without the State of New York as the Council may from time to time determine.

Article II

Section 1. *Divisions.* The Society shall consist of the Professional Division (Fellows) of 4 or more Sections, General Member Division, and Affiliate Organization Division. There shall be 4 Sections of the Professional Division, viz.: Biological Sciences; Psychological and Social Sciences; Clinical Medicine; and Social Welfare.

Additional Sections of the Professional Division or other Divisions may be created by the Society upon recommendation of the Council.

Article III

Section 1. *Membership.* Membership in the Society shall be open to all persons interested in furthering the aims of the organization who meet the requirements as outlined in Section 2c of this article.

Section 2. *Classes of Membership.* There shall be 5 classes of members designated respectively Honorary Members, Fellows, Members, Affiliate Members, and Senior Members.

2a. *Honorary Members:* Any person who has rendered distinguished services to the sciences of Gerontology or Geriatrics may be elected an Honorary Member of the Society by the Council. Honorary Members shall pay no membership dues. They shall have the right of attending the meetings of the Society and of taking part in its discussions but they shall have no vote.

2b. *Fellows:*

1. All persons who, on September 1, 1952, were Members of this Society shall be continued as Members and be designated as Fellows.
2. Any person who in the immediately preceding 3 years has engaged in the study or practice of any aspect of Gerontology or Geriatrics may on application be elected a Fellow of the Gerontological Society, provided:
   a. He or she is nominated by two Fellows in good standing.
   b. He or she is elected by the Council on recommendation of the Committee on Fellowships of the Section involved. Fellows and Members of the Gerontological Society shall be assigned to the Professional Sections in accordance with their own desires, with the approval of the Committee on Fellowship Status of the Section concerned.

2c. *Members:* Any person may be elected to membership by the vote or assent in writing of a majority of the Council. To be eligible for membership an applicant must: (a) be interested in and sympathetic with the purposes of the Society as expressed in its Charter, and (b) be nominated by 2 Members of the Society. Dues of Members shall be fixed in accordance with Article XI of these Bylaws.

2d. *Affiliates:* All voting Members of an Affiliate Organization as hereinafter defined (Article III, Section 3) and of all local chapters of any such Affiliate Organizations shall be Affiliate Members of the Society. Any individual Affiliate may become a Member of the Society. Affiliate Members who are not Members of the Society shall have the right of attending meetings of the Society but shall have no vote and shall pay no dues individually.

2e. *Senior Members:* Any person who has throughout the immediately preceding five years been a Fellow of the Gerontological Society but who is no longer engaged in professional work may upon application to the Council be designated as a Senior Member. Senior Members shall have the right of attending meetings of the Society but shall have no vote and shall pay no dues.

Section 3. *Affiliate Organizations.* Any non-profit corporation, association, or committee organized for purposes similar to those of the national Society may become an Affiliate of the Society, provided that (a) the officers of the national Society, pursuant to such regulations which may be prescribed by the Council, approve the certificate of incorporation, charter, or body of governing rules of such corporation, association, or committee, and (b) it shall agree to comply with a Charter of Affiliation to be issued by the officers of the national Society containing such provisions as shall be prescribed by the Council and renewable annually.

The Council of the Society may terminate a Charter of Affiliation issued to an Affiliate Organization at any time the Council shall determine such action to be in the best interests of the national Society, and the corporation, association, or committee to which such charter had been issued shall thereupon cease to have the privileges of an Affiliate Organization.

3a. Members of the Society in any area may form a local chapter. Local chapters may accept local members who are not members of the National organization but such local members cannot hold office in the local chapter nor vote in the national Society.

Section 4. *Loss of Membership, Resignation, Expulsion.*

4a. Any Fellow or Member of the Society delinquent at least two years in the payment of dues shall cease to be a Member in good standing and shall not be entitled to vote or hold any office of the Society, except that such Member shall be rein-

stated to good standing at any time upon payment of outstanding dues for the then current year.

4b. The resignation of any Fellow or Member shall be in writing and addressed to the Secretary of the Society.

4c. Any Fellow or Member who in the opinion of the Council has violated these By-Laws or regulations prescribed by the Council or whose conduct is prejudicial to the welfare of the Society may be expelled from membership by two-thirds vote of the Council.

Section 5. *Voting.* Each Fellow and Member shall be entitled to one vote at meetings of the Society. Honorary Members, Senior Members, and Affiliate Members shall not vote. Each Affiliate Organization shall be entitled to one vote to be cast by its representative attending meetings of the Society.

Article IV

Section 1. *Membership in the Corporation.* The Members of the Corporation shall be those Fellows and/or Members elected as Members of the Council. The election of a person to the Council shall likewise be an election to membership in the Corporation. No one shall continue to be a member of the Corporation after ceasing to be a member of the Council.

Every meeting of the persons who are members of the Council and of the Corporation, at which there is a quorum, shall be deemed to be a meeting both of the Council and of the Corporation, and any action taken at such a meeting shall be the action of the Council and of the Corporation. Action at such meetings shall be recorded in one set of minutes which need not distinguish between the different capacities in which action is taken.

Article V

Section 1. *Council.* The business and affairs of the Society shall be managed by a Council composed of 17 persons.

Section 2. *Council Membership.* The Council shall be composed of the President, the Past President, the President-elect, the Treasurer, the Secretary, and the Editor of the Journal of Gerontology as *ex officio* members and up to fourteen additional members to be chosen from the Fellows of the Professional Sections, Members of the General Member Division, and the Affiliate Organization Division of the Society in the number determined by the Council. The minimum representation shall be two from each of the Professional Sections, one from the Affiliate Organization Division, and two from the General Member Division.

Section 3. *Nominations.* The Council shall nominate candidates for election as officers of the Society. Council representatives for each Section shall be selected by the Council from a list of nominees submitted by the appropriate Section. Additional nominations may be made by any 5 Fellows and/or Members of the Society in good standing by filing the nominations with the Secretary at least ten days before the annual meeting.

Section 4. *Quorum.* The presence in person of one-fourth of the Council Members shall constitute a quorum. Actions of the Council shall be by majority vote of Council members present. The President shall preside at the Council meetings.

Section 5. *Duties of the Council.* The Council shall:

a. Have general management and control of the affairs and funds of the Society.

b. Appoint a Committee on Publications which shall have jurisdiction over all publications of the Society, including the appointment of an Editor of each such publication.

c. Appoint committees to pass on applications of Fellows and define the guiding principles of eligibility to Professional Sections.

d. Recommend the annual dues for Fellows, Members, and Affiliate Organizations.

e. Prescribe the procedure for and have general supervision over the election of officers of the Society and members of the Council.

f. Provide for nominations of elected officers and members of the Council.

g. Determine the time and place of annual meetings.

h. Set up regulations for admission of corporations, associations, or committees to affiliation with the Society and define policies of affiliation.

i. Appoint additional committees to further the aims of the Society.

The Council may:

j. Determine the number of Council representatives from each Section or Division of the Society.

k. Determine whether or not the Treasurer is to be bonded and if so, in what amount.

l. Appoint or authorize the President to appoint committees on programs, arrangements, regional meetings, public education, research, fellowships, and such other committees as it may deem necessary.

m. Call special meetings of the Society.

n. Make decisions between meetings by majority opinion in writing.

o. Approve specified disbursements for dispersal by the officers of the individual sections. Each of the Professional Sections may make a written statement of any special financial needs for the ensuing year and, with written approval of the Council, draw upon the Central Treasury for necessary funds. Accounting of the use of such funds will be made by the Professional Section to the Treasurer of the Society prior to the annual meeting.

p. Recommend establishment of additional Sections in the Society.

q. Establish special classes of membership for students, interns, etc.

Article VI

Section 1. *Elected Officers.* The elected officers of the Society shall be a President, a President-Elect, a Secretary, and a Treasurer. The President and President-Elect shall be Fellows of the Society.

Section 2. *Nomination.* (See Article V, Section 3.)

Section 3. *Elections.* Election of officers shall be by majority vote at the annual meeting of the Society.

Section 4. *Term of Office.* All officers shall assume their duties at the close of the Annual Business Meeting of the year in which they were elected and shall serve for one year or until their successor is elected and qualified.

The President-Elect shall assume the office of President at the close of the Annual Business Meeting which is held one year following his election.

Section 5. *Vacancies.* If the office of the President shall become vacant the President-Elect shall assume such office. If for any reason the succession of the President-Elect shall become impossible, a successor to the office of President shall be appointed by the Council for the remainder of the unexpired term of the President. If the office of the Secretary or Treasurer shall become vacant, a successor shall be appointed by the Council for the remainder of the unexpired term. If the office of the President-Elect shall become vacant, a successor shall be nominated by the Council but such office shall not be filled except by confirmatory vote of the Society at the next annual meeting.

Section 6. *Duties of the President.* The President shall preside at annual and special meetings of the Society and at meetings of the Council. He shall be responsible for the administration of the business of the Society, shall be an *ex officio* member of all committees, and shall perform such other duties as are not specifically delegated to other officers or committees. He may call special meetings of the Society.

Section 7. *Duties of the President-Elect.* The President-Elect shall perform the duties of the President in the absence or disability of the President and shall be an *ex officio* member of all committees.

Section 8. *Duties of the Secretary.* The Secretary shall arrange to have written notices of all meetings sent to all Members as provided in the Bylaws. He shall also act as Secretary of all meetings of the Society and of the Council.

Section 9. *Duties of the Treasurer.* The Treasurer shall receive and disburse and account for all funds belonging to the Society.

Article VII

Section 1. *Section Officers.* Each Professional Section, the General Member Division, and the Division of Affiliate Organizations may elect a Chairman and Secretary of its respective group.

1a. *Council Representatives.* Each Professional Section, as well as the Division of General Members and the Division of Affiliate Organizations, shall select one or more nominees for their Council representative as vacancies occur. Selection may be by a Nominating Committee of the respective Section or Division, but a vote shall be taken at the annual meeting of the Section before the names are certified to the Council. Terms of office shall be arranged so that the term of office of only one representative of a Section or Division shall expire in any one year. Final election of all officers of the Society, including representatives to the Council, shall be by vote of all Fellows and Members of the Society present at the annual meeting.

Section 2. *Vacancies.* If vacancies occur among representatives to the Council, successors from the same Section or Division shall be nominated by the Council and elected at the next annual meeting for the unexpired portion of such terms.

Article VIII

Section 1. *Meetings of the Society.*

1a. *Annual meetings.* Annual meetings of the Fellows and Members of the Society shall be held on the second Friday of September unless the Council designates a different day. The place of meeting shall be designated by the Council.

1b. *Special meetings.* Special meetings of the Fellows and Members of the Society may be called at any time by the President or the Council and shall be called by the President upon the written request therefor of 25 Fellows and/or Members.

1c. *Regional meetings.* The Council shall upon the request of 25 Fellows and/or Members call a regional meeting of the Society at any time and place, for the presentation of programs and the promotion of personal intercourse. Such a request shall be made in writing at least six weeks before the proposed date of meeting. Such meeting shall be held in accordance with the Constitution and Bylaws of the Society, and if the regular officers of the Society cannot be present the President shall appoint a committee from among the petitioners to conduct the meeting. The Committee through a Secretary chosen by them shall forward an account of the proceedings of the meeting to the official Secretary of the Society for insertion in the minutes. No general business of the Society shall be transacted at such regional meetings.

1d. *Notice of meetings.* Written notice of the time, place, and purposes of the annual meeting and all other meetings of the Members and Fellows of the Society shall be mailed or caused to be mailed by the Secretary to each Fellow and Member addressed to him at his address as it appears on the records of the Society not less than ten and not more than forty days before the meeting.

1e. *Quorum.* At all meetings of the Society, 20 Fellows present in person or by proxy shall constitute a quorum for the transaction of business, but a lesser number may adjourn the meeting to a day specified.

1f. Two *Inspectors of Election* shall be chosen at each annual meeting of the Fellows and Members of the Society to act at such meeting and at all special meetings of the Society until the succeeding annual meeting.

1g. *Reports.* At the annual meeting of the Fellows and Members of the Society, the Council shall present a report, verified by the President and Treasurer or by a majority of the members of the Council, showing the whole amount of real and personal property owned by the Society, where located and where and how invested, the amount and nature of the property ac-

quired during the year immediately preceding the date of the report and the manner of acquisition; the amount applied, appropriated, or expended during the year immediately preceding such date, and the purposes, objects, or persons to or for which such applications, appropriations, or expenditures have been made; and the names and places of residence of the persons who have been admitted to membership in the Society during such year, which report shall be filed with the records of the Society and abstract thereof entered in the minutes of the proceedings of the annual meeting.

Section 2. *Minutes of the Council.*

2a. The annual meeting of the members of the Council shall be held each year immediately preceding the annual meeting of the Fellows and Members of the Society. Special meetings of the Council may be called by the President and shall be called by the President upon the written request of 5 members of the Council at any time.

2b. Written notice of the time and place of all meetings of the Council shall be mailed by the Secretary to each member of the Council not less than five days before the meeting. Notices of special meetings shall also state the purposes of such meetings.

Article IX

Section 1. *Official Organs.* The JOURNAL OF GERONTOLOGY shall be an official organ of the Society. All of the assets of the JOURNAL shall be the property of Gerontological Society, Inc., and all of the income and revenue of the JOURNAL OF GERONTOLOGY shall be paid or transmitted to the Treasurer of the Society and its bills shall be paid by the Treasurer upon the presentation of proper vouchers.

Article X

Section 1. *Seal.* The seal of the Corporation shall have inscribed thereon the following words and figures: "Gerontological Society, Inc., 1945."

Article XI

Section 1. *Dues.* Each Fellow and Member shall pay annual dues in an amount determined by a majority vote at the annual meeting of the Society upon recommendation of the Council. The dues for Fellows shall include the annual cost of a subscription to the JOURNAL OF GERONTOLOGY. Dues for Members may exclude subscription to the Journal of Gerontology when approved by the Council.

Honorary and Senior Members are exempt from payment of dues.

Affiliate Organizations shall pay annual dues to the Society, an amount determined by a majority vote at the annual meeting of the Society upon recommendation of the Council. The dues for Affiliate Organizations shall include the cost of at least one subscription to the JOURNAL OF GERONTOLOGY.

Article XII

Section 1. *Amendment or Repeal.* These Bylaws may be amended or repealed by the affirmative vote of at least three-fourths of the Fellows and Members present at any meeting of the Society provided the proposed amendment or repeal is approved by the Council and a written notice of the proposed amendment or repeal has been mailed to each Fellow and Member at least ten days in advance of the meeting.

Article XIII

Section 1. *Purchase, Sale, etc., of Real Estate.* No purchase of real property or sale, mortgage, or lease of the real property of the Society shall be made unless authorized by the vote of at least two-thirds of the whole number of the Council, at a meeting duly called and held.

Section 2. No sale or mortgage, other than a purchase money mortgage, or real property of the Society within the State of New York or lease thereof for more than five years, shall be made without leave of the Supreme Court in the Judicial District in which some of the property is located.

Section 3. The provisions of the foregoing Sections 1 and 2 of this Article XIII shall not apply to real property acquired on a sale in any action or proceeding for the foreclosure of a mortgage owned by the Society by deed in lieu of foreclosure of a mortgage owned, either in whole or part, whether in certificate form or otherwise, by the Society.

The following persons served on the Committee on Revision of Constitution and Bylaws (1957):

Warren Andrew, Chairman
Wilma Donahue
Joseph T. Freeman
Ollie Randall
Nathan W. Shock
Clark Tibbitts

History of Gerontological Society, Inc.

MARJORIE ADLER, M.A., Administrative Secretary

The meeting in Cleveland, October 31 - November 2, 1957, marked the tenth annual scientific meeting of Gerontological Society, Inc., which was incorporated pursuant to the Membership Corporations Law of the State of New York in 1945. The Society was organized in order to promote scientific study of aging and to unite the activities of gerontologists working in various scientific fields, as well as those responsible for the care and treatment of the aged. It includes in its membership physicians, physiologists, psychologists, anatomists, biochemists, sociologists, botanists, psychiatrists, pharmacologists, geneticists, zoologists, endocrinologists, and administrators.

Gerontological Society is a direct outgrowth of the Club for Research on Ageing* which was organized in 1939, through the efforts of Dr. W. deB. MacNider. The members of the Club in 1945 were: W. M. Allen, J. C. Aub, B. Bauer, W. B. Cannon,† A. J. Carlson,† A. E. Cohn,† E. V. Cowdry, W. M. Crocker,† E. T. Engle, L. K. Frank, C. J. Hartman, A. B. Hastings, F. L. Hisaw, R. G. Hoskins, C. M. McCay, W. deB. MacNider,† W. R. Miles, R. A. Moore, J. Oliver, O. Riddle, H. S. Simms, N. W. Shock, E. J. Stieglitz, and G. B. Wislocki.† The fifteen conferences held by the Club for Research on Ageing were sponsored and supported by the Josiah Macy, Jr. Foundation.

A Committee on Journal was appointed in 1944 under the Chairmanship of R. G. Hoskins to explore the possibilities of initiating a publication in the field of gerontology after the war. Other members of this Committee were C. J. Hartman, W. R. Miles, and E. J. Stieglitz. The report of the Committee (November 15, 1944) included the following recommendations: that the Journal be planned to have a broad appeal—to deal with the problems of aging from a variety of points of view, such as biologic, medical, sociologic, and economic; that the Journal at first be a quarterly publication; that the editorial personnel include an Editor-in-Chief, an Editorial Board (selected to represent the various specialities) and a larger group of collaborators to include all the members of the Club for Research on Ageing willing to serve; that the Journal include an Abstract Department under the immediate supervision of an Abstract Editor; that articles be accepted for publication irrespective of country of origin; that efforts be made to secure a subvention to meet expenses until the Journal should become self-supporting; that the Chairman of the Club appoint a committee consisting of himself and three others to nominate an Editor-in-Chief; and that a standing Executive Committee on Publication be elected to represent the Club at all times in the management of the Journal, the Committee to be empowered to receive and disburse monies and to make contacts in behalf of the Club.

Formation of Gerontological Society

At a meeting of the Club for Research on Ageing held February 10, 1945, it was voted to incorporate the Club as a non-profit organization. The meeting of the incorporators was held on May 8, 1945. The name "Gerontological Society" was adopted, and the Certificate of Incorporation was signed by E. T. Engle, L. K. Frank, Jean Oliver, O. Riddle, and H. S. Simms.

The Certificate of Incorporation provided that:

The Corporation was to operate principally in the U.S.A. but might carry on its operations anywhere throughout the world.

The principal office of the corporation was to be located in the Borough of Manhattan and in the City, County, and State of New York. The number of its directors would be not less than five and not more than twenty.

No director, council member, member, officer, or employee of the corporation would receive any pecuniary profit for the operations thereof other than reasonable compensation for services rendered, reimbursement of expenses incurred in its service, or benefits received as a proper beneficiary of its strictly scientific and charitable purposes; nor would any director, council member, member, officer or employee at any time have any personal interest in any property or assets of the corporation; nor would any director, council member, member, officer, or employee, in the absence of fraud or bad faith, be personally liable for the debts, obligations, or liabilities of the corporation.

For the accomplishment of any of its purposes the corporation would also have power to acquire property by grant, gift, purchase, lease, bequest, or device and without limitation as to character, amount or value, except with such limitations, if any, as the legislature might impose; and to hold and dispose of the same to invest, reinvest, deal with and expend the property of the corporation in such manner as the trustees might deem best.

No part of the activities of the corporation would attempt to influence legislation by propaganda or otherwise.

Mr. George E. Johnson handled the legal matters pertaining to the incorporation of the new Society, the purposes for which were "to promote the scientific study of aging, in order to advance public health and mental hygiene, the science and art of medicine, and the cure of diseases; to foster the growth and diffusion of knowledge relating to problems of aging and of the sciences contributing to an understanding thereof; to afford a common meeting ground for representation of the various scientific fields interested in such problems and those responsible for care and treatment of the aged; all without profit to the corporation or its members."

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* In the name of this Club, aging was spelled with an "e." The spelling of "aging" rather than "ageing" was adopted for the Journal on the recommendation of Dr. Simms (May 5, 1945), who stated that Webster's Dictionary gave "aging" as first choice and "ageing" as second choice. The laboratory dictionary gave "aging" as the spelling with no second choice. The words "caging," "paging," "raging," and "waging" are spelled without an "e," whereas similar words in which the "e" was included were not evident. The spelling with the "e" is considered somewhat archaic.

† Deceased.

The first meeting* of the newly formed Gerontological Society was held June 15, 1945, in New York City; E. T. Engle, L. K. Frank, O. Riddle, and H. S. Simms, four of the five incorporators, were present. R. A. Moore also attended. The by-laws and articles of incorporation were approved and Mr. Frank was instructed to file the articles of incorporation with the Secretary of State of New York. In accordance with the provisions of the Bylaws, the members of the Club for Research on Ageing were included as members of the Gerontological Society and the officers and members of the Executive Committee of the Club constituted the first Council.† The following officers were elected to hold office until the close of the first annual meeting in 1946: W. deB. MacNider, President; R. A. Moore, Treasurer; and E. J. Stieglitz, Secretary. It was voted that the Society would have no dues during the year 1945.

On November 7, 1946, the Gerontological Society, Inc. was declared to be exempt from federal income tax by the Commissioner of Internal Revenue.

At the second meeting of the Corporation and Council on November 14, 1945, in New York City, dues for the year 1946 were assessed at $10.00 for Active Members ($6.00 to cover a subscription to the new Journal of Gerontology and $4.00 to be used for membership expenses), and $25.00 for Sustaining Members, likewise with a subscription to the Journal. Dues for Honorary and Senior Members were waived unless a subscription to the Journal was desired, in which case the member would pay the usual subscription price of $6.00.

The Council was given the power and the obligation to control the affairs and funds of the Society, to appoint a Committee on Publications to have jurisdiction over all publications of the Society, including the appointment of an editor of each such publication, to appoint a committee to pass on applications of new members and define eligibility, to recommend annual dues, to prescribe procedure for and have supervision over the election of officers and members of the Council, to provide for nominations of elected officers and members of the Council, and to determine the time and place of annual meetings. The Council was also given the authority to determine whether or not the Treasurer was to be bonded, to appoint or authorize the President to appoint committees, to call special meetings, and to make decisions between meetings by majority opinion in writing.

The Council was organized to include the President, the President-elect, the Treasurer, the Secretary, and the Editor of the Journal of Gerontology as ex officio members (to hold offices until the end of the next annual meeting), and nine additional members to be elected by the active members of the three sections of the Society in such a manner that the term of one member from each section would expire each year.

A Committee on Publication was appointed, consisting of L. K. Frank, E. J. Stieglitz, and R. G. Hoskins as Chairman, and an editor for the new Journal, R. A. Moore, was selected. The Publication Committee met in New York, April 4, 1945, to plan the general policy of the Journal, and Dr. Moore presented an outline for the Journal, designed to appeal to the numerous groups interested in the problems of aging, especially from the economic, sociologic, psychologic, physiologic, and medical aspects.

Josiah Macy, Jr. Foundation

In order to launch such an enterprise, however, the need for a subvention to defray editorial expenses during the initial period was recognized (it was anticipated that the Journal would become completely self-supporting within a period of two to four years). On behalf of the Publication Committee, Dr. Hoskins made a formal application to the Josiah Macy, Jr. Foundation for an initial allocation of $3,750 in the anticipation that further grants might be made, presumably in diminishing amounts, for a period up to four years.

On August 28, 1945, a grant of $4,000 was made to the Society by the Josiah Macy, Jr. Foundation, the grant to be used for the salary of an editorial assistant, for editorial office and other incidental expenses, and for establishing a Registry of Gerontology ($250) at the Surgeon General's Museum in Washington, D. C.

The Registry of Gerontology* was the result of a decision by the Club for Research on Ageing to cooperate in establishing a repository for tissues obtained at autopsy of aged human beings.

Subsequent grants were also made by the Josiah Macy, Jr. Foundation, totalling $24,000. Thus it was through the generous assistance of the Josiah Macy, Jr. Foundation and the good offices of Dr. Frank Fremont-Smith,† Medical Director of the Foundation, that the publication of the Journal of Gerontology was assured in its early years.

JOURNAL OF GERONTOLOGY

Several points were agreed upon by the Committee on Publication: first, that the Journal would carry articles, not only in the biologic sciences including medicine, but also in the social sciences and in the humanities; second, that a non-technical supplement would be issued in which the original articles published in the scientific journal would be abstracted and digested into papers not exceeding 2000 to 2500 words in length.

Three publishers considered that the time was ripe for establishing such a journal and that wide support for it could be expected. Each of these publishers was confident of his judgment and offered to guarantee all the expenses of manufacturing and distributing the Journal. The Society would retain complete ownership of the Journal.

Charles C Thomas of Springfield, Illinois, was selected as publisher of the Journal and Non-Technical Supplement. A contract was drawn up (to run for two years and to be renewed by mutual consent thereafter) and was signed by R. G. Hoskins, as Chairman of the Publications Committee. The first issue of the Journal of Gerontology (January) appeared in the Spring of 1946, and subscription price was $6.00 per volume of four issues, plus 50 cents postage to all countries outside the Western Hemisphere. It was realized that the first Journal in a relatively new field could not have sufficient income to meet all three major items of

* See Appendix A for complete list of meetings.
† See Appendix B for complete list of officers and members of the Council.

* See Appendix C regarding the Registry of Gerontology.
† Dr. Fremont-Smith is an Honorary Member of the Gerontological Society.

expense: printing costs, publishing and promotional costs, and editorial costs. Accordingly, the Society applied for and was given a grant of $4,000 in 1946 by the Josiah Macy, Jr. Foundation to cover the costs of the editorial office.

As originally conceived, the Journal was planned to include the following sections:

Original articles (6 to 8 in each issue) from all interested fields without too much emphasis on any one, the subject to be directly related to aging,

Book reviews,

Browsing Through the Ages—a scholarly treatment of some topic from the field of art or literature as related to aging and the aged,

Current Comment—editorial comment,

Organization Section for the publication of material related to the Society,

Gerontologic Reviews, of not over 15 printed pages, written on invitation by an authority in the field,

Legal Aspects,

Abstracts of Current Periodical Literature—a combination of review and abstract in about 500-800 words (this section was never published),

Index to Current Periodical Literature—a cumulative index of literature copied from the style of the Quarterly Cumulative Index Medicus, both serious lay and scientific journals to be indexed,

Volume contents and Index to the volume to be bound in the October issue.

In view of the diversity of interests and knowledge represented, two addenda on each paper were written in the editorial offices. First, a brief sketch about the author so that the sociologists might come to know the clinicians, for example, the second, an abstract comment written in non-technical language so that those in one field might understand clearly the work in other fields. The abstract comment was submitted to the authors for correction of fact, but not of style and wording. These two items appeared on page 2 of each article.

An abstract of each paper was published at the end of each paper in English, French, Spanish, and Russian, although the foreign abstract feature was omitted after the April, 1946, issue because of the expense involved in the translations.

The quotation "To add life to years, not just years to life" was adopted for use on the masthead of the Journal of Gerontology. The origin of this phrase has been variously attributed and comments were requested from Journal readers in the July, 1949, issue. It was thought by some to be a quotation from Oliver Wendell Holmes or Benjamin Franklin. The Librarian of the Boston Athenaeum was unable to find the phrase in Holmes' writing, or among the writings or speeches of those concerned with geriatrics: Ralph Barton Perry, Kenneth Walker, L. E. Emerson, and Cicero. She remarked that the person suggesting Franklin might have had in mind Poor Richard's saw in his Almanac for 1738, "Wish not so much to live long as to live well."

The Non-Technical Supplement

With the idea that a large segment of the population over the age of 60 would be interested in what was being done for them by science, it was decided to publish a Non-Technical Supplement to the Journal of 12 to 20 pages each quarter, to be paged and bound separately and included on an introductory basis with each subscription to the Journal, but also available separately at $3.00 per volume of four issues. Each article in the Journal was abstracted and rewritten in nontechnical language, varying from 750 to 1500 words in length, and was submitted to the authors of the original scientific papers for correction of fact. Six men and women who had distinguished themselves in the field of interpretation of science to the laity were asked to serve as Consultants to the Editor-in-Chief in the publication of the Supplement, which was copyrighted but with blanket permission to reprint granted to all reputable newspaper associations, newspapers, and lay magazines. This innovation was in keeping with the statement that "the time has come when the sciences, both natural and social, may with profit bring to the people, knowledge of what is being done in their name and for them."

The plan of a Non-Technical Supplement from 12 to 15 pages was expanded to 40 to 50 pages per issue upon the advice of the publisher, C. C Thomas, and 238 pages were published in volume 1.

Both the Journal of Gerontology and the Non-Technical Supplement refrained from taking part in any economic propaganda, but supported all efforts directed to adequate medical and social care of the aged.

Printing of the Journal

The inside front cover of the first issue of the Journal of Gerontology listed W. deB. MacNider in addition to R. G. Hoskins, L. K. Frank, and E. J. Stieglitz as members of the Committee on Publications. Miss Margaret Bronson, whose employment with the Journal began on August 1, 1945, was listed as Assistant to the Editor. V. Korenchevsky was Correspondent for Great Britain, B. A. Houssay for Argentina, and R. Courrier for France. E. V. Cowdry was Consultant to the Editor for the Natural Sciences, H. G. Multon for the Social Sciences, and R. F. Jones for the Humanities. There was an Advisory Editorial Board consisting of 32 members.

Mrs. Rita Noah became an additional Assistant to the Editor in April, 1946, a position which she held until March, 1947. Miss Bronson terminated her association with the Journal in October, 1946.

Six months after the contract was signed and before the first issue of the Journal appeared, Mr. Thomas asked to be relieved of his contract to pay the printing costs of the Non-Technical Supplement, but agreed to continue to act as publisher. Mr. Thomas believed that the returns from his promotional efforts for subscription for the Non-Technical Supplement were disappointing, and therefore he considered the whole idea unsound and was unwilling to continue. The Committee on Publications of the Society met and decided, with the consent of the Josiah Macy, Jr. Foundation, to use a part of their grant for editorial expense for the printing of the Non-Technical Supplement for 1946.

At the end of the first year of publication the circulation of the Journal of Gerontology was 933, that for the Non-Technical Supplement 98.

It developed that publication costs were higher and subscriptions less than originally anticipated by the publisher, and in December, 1946, Mr. Thomas wrote that he wished to be relieved of his entire contract.

At the second annual meeting of the Council, February 2, 1947, in New York City, Dr. Moore presented the problem and posed the questions of whether the Society wished to continue publication of the Journal or discontinue it for the time being, whether the editorial policy of a multidisciplinary Journal should be pursued, or should the Journal be oriented to biology and medicine, whether the Supplement should be continued and if so under what conditions, and how the project was to be financed. The Council approved the principle of continued publication of a multidisciplinary Journal having the same general editorial policy as that of the first issues, and authorized the Publication Committee to continue to publish a Non-Technical journal provided that it could be financed, although such a journal, it was believed, should differ somewhat from the first four issues of the Non-Technical Supplement. Publication of the Non-Technical Supplement was discontinued at the end of 1946 and has not been resumed.

The Josiah Macy, Jr. Foundation was again approached for a grant and an allocation of $16,000 was made ($8,000 for 1947, $5,000 for 1948, and $3,000 for 1949). Charles C Thomas was discharged from all responsibilities for the Journal as of January 1, 1947. The George Banta Publishing Company of Menasha, Wisconsin, which had printed the Journal in 1946, agreed to continue with the printing for 1947, and Gerontological Society commenced and has continued acting as its own publisher. It was understood both by the Society and the Josiah Macy, Jr. Foundation that the general editorial policy of a multidisciplinary journal would be continued, that efforts would be made to expand the membership of the Society, and that an active promotional campaign for Journal subscriptions would be carried on. All of these efforts were to be directed toward making the Journal self-supporting as soon as possible.

In October, 1947, Banta announced that because of current conditions in the printing industry they would be unable to continue the printing of the Journal, and arrangements were made with the Ann Arbor Press in January of 1948 to print the Journal, the editorial office to continue with the publication. Meyer and Thalheimer (Baltimore) printed the Journal 1950-1953; Maurice Lesser Company (Baltimore) 1954-1955; Von Hoffmann Press (Jefferson City, Mo.) 1955-1956; Eden Publishing House (St. Louis) 1956 - present time.

Chronologic Development of Society and Journal

In March, 1947, Dr. A. I. Lansing and Dr. N. W. Shock accepted appointments as assistant editors of the Journal. Dr. Lansing was in charge of recommending acceptance or rejection of papers and final checking of manuscripts before printing and Dr. Shock of the Gerontological Review and Book Review Section. Also in March, 1947, Mrs. Marjorie (Lawson) Adler was employed as Assistant to the Editor and assumed the editorial duties of Mrs. Noah, together with the new publishing responsibilities.

The Legal Aspects Section was suspended in 1948 since the State Legislature reports prepared by the Law and Legislative Reference Section of the Social Administration Library, on which the material for the section was based, were discontinued because of federal budget reductions.

Dr. Lansing resigned as Assistant Editor on September 1, 1948, and Dr. J. E. Kirk accepted the appointment as Managing Editor on September 22, Dr. Shock continuing as Assistant Editor. Dr. Kirk became Editor-in-Chief November 12, 1950.

At the fourth meeting of the Corporation and Council January 8, 1949, in New York City, held in conjunction with the First Annual Scientific Meeting of the Society, it was voted to increase the subscription price of the Journal from $6.00 per year to $8.00 ($8.50 for subscriptions outside the Western Hemisphere); membership dues were to remain at $10.00.

In 1949 Dr. Kirk was elected Treasurer of the Society, nominated by the previous Treasurer, Dr. Moore, who had originally accepted the Treasurership because it was his belief that since publication of the Journal was the major expense of the Society, the Editor and Treasurer should be the same person.

With the April, 1949, issue an Historical Section was added to the Journal in connection with the Browsing Through the Ages Section, both of which were later discontinued.

Four new foreign correspondents were added at this time: F. Bourlière for France (to replace R. Courrier), F. Vega-Diaz for Spain (until 1957), T. Geill for Denmark, P. Hanssen for Norway (until 1951). E. Jalavisto was appointed correspondent for Finland in 1950 and J. F. Fleetwood for Ireland in 1951. In January, 1952, seven additional foreign correspondents were added to the staff: W. S. Hartroft for Canada (until 1955), G. Mars for Italy, E. Aguirre Pequeño for Mexico, J. de Reis, Jr. for Portugal (until 1954), O. W. Frewin for South Australia, E. Eckerström for Sweden, and J. M. Sosa for Uruguay. In October, 1954, R. Schaus joined the staff as correspondent for Luxembourg, and R. I. Macdonald (Canada) and R. J. van Zonneveld (The Netherlands) were added in 1955. W. Doberauer became correspondent for Austria in 1957.

Beginning with the April, 1950, issue of the Journal of Gerontology, Dr. N. W. Shock took charge of the Index to Current Periodical Literature section, which is classified according to the categories used in the Classified Bibliography of Gerontology and Geriatrics (Stanford University Press, 1951 and 1957); in so far as possible, references are classified according to organ systems. Dr. Shock also was responsible for the Contents and Contributors section, which was begun in January, 1952, as a replacement for the biographical sketches and abstracts of papers previously published. This section was, however, discontinued with the October, 1953, issue.

In January 1950, the Publications Committee consisted of R. G. Hoskins, Chairman, E. W. Burgess, and F. Zeman. With the January, 1951, issue of the Journal, the Publications Committee became the Editorial Board and Dr. Moore was appointed Chairman, with E. W. Burgess, R. G. Hoskins, and P. D. White as members of the Board. Dr. White subsequently resigned and was replaced by H. E. Jones. Dr. Lansing became Chairman of the Editorial Board in January, 1957, with A. A. Hellbaum, J. E. Birren, and E. W. Burgess as members of the Board.

The Fourth Annual Scientific Meeting was held in St. Louis, September 9-14, 1951, in conjunction with the Second International Congress of the International Association of Gerontology, which the Gerontological Society sponsored. The Society also undertook the publication of the program for the Congress, which appeared as a supplement to the July, 1951, issue of the Journal of Gerontology.

In his Presidental report for 1951, Dr. Moore brought up the question of the establishment of a foundation to raise money. The general conclusion was that the time was not an opportune one to institute a public foundation on a national scale. Dr. Moore suggested that the Society establish an affiliate type of membership for the laity and start a modest program to interest the public in the problems of gerontology. It was recommended that the Sections of the Society (Biological Research, Medical Research, and General) be reorganized to give appropriate recognition to all professional groups and scientific disciplines concerned with the problems of aging and that a new category of membership be established to include lay people interested in aging from either a personal or service standpoint at a lower membership fee without subscription to the Journal. It was regarded as essential that the Society prepare material of interest to lay people to be distributed in lieu of the Journal of Gerontology.

At the business meeting that year (1951) the desirability of providing information of practical value to organizers of community projects was also considered. It was believed desirable that the Society sponsor the preparation and circulation of such material, preferably as a supplement to the Journal of Gerontology, since it did not seem feasible to inaugurate a special supplement at that time.

A contribution of $100 was voted to the National Society for Medical Research in 1952. This amount was continued in 1953, but was reduced to $50 in 1954 and continued annually on that basis.

The subscription price of the Journal of Gerontology was raised from $8.00 per volume of four issues to $10.00 at the annual meeting in 1952, effective with volume 8 (1953).

The Gerontological Society became an affiliate of the American Association for the Advancement of Science and Dr. Wilma Donahue was appointed as the Society's representative on the Council of the AAAS in 1954, for a term of three years. Dr. Lansing replaced Dr. Donahue on the Council in 1957.

Council approval (1954) was given for the appointment of Committees to:

1. Reevaluate and study the policy and content of the Newsletter,
2. Review television programs of problems of aging being compiled with authority to decide on possible sponsorship without financial cost to the Society,
3. Develop state and local organizations and their affiliation with the Gerontological Society,
4. Review the constitution and by-laws of the Gerontological Society,
5. Explore the possibilities of obtaining research fellowships for young investigators in the field of gerontology and set up machinery for evaluation of the qualifications of the applicants and administration of fellowship funds,
6. Study and recommended methods for bringing research problems within the field of gerontology to the attention of young people of college level with the purpose of promoting research.

Beginning with the January, 1955, issue of the Journal, a division was made into Section A (Biological Sciences and Clinical Medicine), Section B (Psychological and Social Sciences and Social Welfare), and Section C (Organization Section and Index to Current Periodical Literature).

The Council approved (1955) appointment of a Committee to Investigate the Existence and Characteristics of Residencies and Clinical Training Programs in Geriatrics, and a preliminary report of this Committee was presented at the 1956 meeting by the Chairman, Dr. R. R. Commons. The Committee found that of the 65 medical schools canvassed by questionnaire, two have departments of geriatrics and/or undergraduate elective courses in geriatrics or gerontology and that three schools reported postgraduate courses available for practicing physicians.

The Chairman of the Membership Committee, Dr. Donahue, was authorized to select key people in various geographic areas of the United States to be responsible for the promotion of memberships in their respective areas for 1957 and 1958.

Specific standards for exhibits at the annual meetings of the Society were drawn up by a committee under the Chairmanship of Dr. Kirk and were accepted by the Council, together with the recommendations regarding the membership of the Committee and its duties. Journals & Exhibits, Inc. in cooperation with the Chairman of the Exhibits Committee, Dr. Freeman handled all exhibits for the 1957 meeting.

Annual dues for Fellows and Full Members, which had been assessed at $10.00 since the beginning of the Society, were increased to $12.50 effective in 1957.

At the 1956 meeting the position of Executive Secretary was created and Mrs. Adler was appointed to this position in addition to her other duties. The title was changed to Administrative Secretary a few months later.

The Council decided at the 1957 meeting to set aside a reserve fund consisting of 50 per cent of the unexpended operating balance available December 31, 1957, and that beginning January 1, 1958, 5 per cent of the annual income from dues and subscriptions be added to this reserve fund, which could be appropriated by the Council to meet specific needs of the Society in the future.

It was also decided that it is not the responsibility of the Society to raise funds for the publication of monographs or supplements to the Journal, but that if a manuscript were acceptable to the Editorial Board and the Editor and the author could provide the financing, publication might be approved.

A distinction was made between a Professional Member and a General Member, the former would be a Member of one of the Professional Sections and would receive the Journal, and the latter would be permitted to receive the Journal or not as he chose.

Also at the 1957 meeting it was agreed that the Society should establish a procedure for appointing a representative to the International Association of Gerontology and that the Society would pay the regular dues (which had been set at 15 cents per Member by the IAG) for each Fellow and for each Professional Member.

Bylaws

The original Bylaws, adopted June 15, 1945, and revised February 18, 1946, at the third meeting of the Corporation and Council and the First Annual Meeting of Gerontological Society, Inc. (published in the April, 1946, issue of the Journal of Gerontology, pp. 266-269) provided that the Society would consist of three sections: medical research, biological research, and the general section. All persons who were members of the Club for Research on Ageing on June 15, 1945, were charter active members of the Gerontological Society. Other persons could become members provided they were nominated by two members in good standing and were elected by the Council upon recommendation of the Committee on Membership. Four classes of members were provided: Honorary, Sustaining, Senior, and Active. All members might attend meetings, but honorary and senior members would not receive the publication of the Society unless they chose to pay the annual dues (including a subscription); only Active Members would have the right to vote and hold office. The members of the Corporation were those Active Members elected as members of the Council; the election of a person to the Council likewise constituted election to membership in the Corporation. No one would continue to be a member of the Corporation after ceasing to be a member of the Council; a meeting of the Council and of the Corporation would be deemed to be a meeting both of the Council and the Corporation.

The the annual meeting in 1952 revised Bylaws, proposed by the Committee and previously circulated to all members of the Society, were adopted (published in full in the January, 1953, issue of the Journal). Under the new Bylaws, all members of the Society on September 1, 1952, became Fellows of the Professional Division. The members approved a motion that the President appoint a committee to work out procedures for determining requirements for Fellowship status in the Professional Division and policy regarding affiliation of organizations.

Three Divisions of the Society were created: Professional, General Member, and Affiliate Organization. The Professional Division consisted of four Sections: Biological Sciences, Clinical Medicine, Psychological and Social Sciences, and Social Work and Administration (changed to Social Welfare in 1956). Five classes of membership were established: Honorary, Fellows, Members, Affiliates, and Senior Members. Only Fellows and Members were given the privilege of voting at meetings of the Society.

Membership in the Council was increased to 17 persons (1952), the five officers and the Editor of the Journal of Gerontology as ex officio members and 11 additional members. The members were to serve on the calendar basis, commencing their terms of office on January 1 rather than at the close of the Business Meeting.

Provision was made in the new by-laws for each Professional Section, the General Member Division, and the Division of Affiliate Organizations to elect a Chairman and Secretary of its respective group. Each Professional Section as well as the Division of General Members was to elect two representatives to the Council for a term of three years and the Division of Affiliate Organizations one member for a three-year term.

The Bylaws were revised again in 1957 after having been circulated to the membership (published in full in this issue, page 90-93). The major changes were: 1) Membership, as well as Fellowship, may be held in any of the four Professional Sections of the Society, 2) the distinction between a regional or state chapter of the Society and affiliate groups was clarified, 3) Council representatives for each Section would be nominated by the Council from a list of nominees submitted by each Section, 4) specific funds from the Society may be allocated for use by each Section in conducting its affairs, and 5) new officers would assume their duties at the close of the annual business meeting.

Dr. R. J. Havighurst and Dr. Bernice Neugarten accepted appointments as Associate Editors for Section B (Psychological and Social Sciences and Social Welfare) of the Journal, effective with the January, 1958, issue. Dr. J. E. Birren was appointed Assistant Editor, Dr. Kirk and Dr. Shock continuing as Editor-in-Chief and Assistant Editor, respectively.

Newsletter

The establishment of a Newsletter to be sent to all Fellows, Members of the Society, and subscribers to the Journal was approved at the 1953 annual meeting. A Committee, consisting of O. J. Kaplan, Chairman, Wilma Donahue, C. Tibbitts, J. E. Kirk, and N. W. Shock was appointed to draw up a statement of editorial policy, to survey publication costs, and to prepare material for issues to be published in 1954. General Members were permitted to elect to receive the Newsletter at $2.50 per year in lieu of the Journal of Gerontology, but this option was not made available to Fellows and Full Members.

The first issue of the quarterly Newsletter was published in June, 1954, as a four-page copy, offset printed, but only three issues were published that year. The March, 1956, issue appeared as an eight-page copy and the following issue as a twelve-page copy. Beginning with the March, 1957, issue copies have been 12 pages in length and set in type.

Dr. Kaplan was appointed as Editor of the Newsletter for a three-year term, and the term was renewed in 1956. Members of the Editorial Board of the Newsletter are E. L. Bortz, Wilma Donahue, E. B. Ferguson, J. T. Freeman, S. M. Horvath, L. Kuplan, N. W. Shock, and C. Tibbitts.

Fellowship Status

The Committee which was appointed to draw up qualifications for Fellowship status in the four Professional Sections of the Society drew up a report which was published in full in the January, 1954, issue of the Journal of Gerontology (pages 85-86). A new Committee was appointed in 1956 under the Chairmanship of H. S. Simms to write a code on Fellowship qualifications which would be fair to all four Sections of the Society. The Uniform Code of Requirements for Fellowship Status adopted at the 1957 meeting is published in this issue on page 87.

At the meeting in 1954 the first new group of Fellows was elected to Fellowship Status in the Society, and the Secretary was instructed to notify those thus elected.

Also at the 1954 meeting it was decided that membership certificates be made available on request to Fellows of the Gerontological Society at a fee to be set

to cover the cost, the details to be worked out by the Membership Committee. This Committee was also charged with investigation of the advisability of issuing membership cards to all members. Dr. J. T. Freeman was given the responsibility for drawing up a suitable certificate, and this was made available to Fellows of the Society beginning in 1956.

In 1955 it was agreed that all Fellowship applications were to be sent to the Senior Council representative of the appropriate Section, who would be responsible for circulating the applications among his Committee and for obtaining additional information from the applicant where this was regarded as necessary.

Affiliate Organizations

It was provided (1952) that local chapters (or Sections) of the Gerontological Society might be formed among State and local groups by Fellows of the Society in collaboration with others. The Constitution and By-laws of the local group would have to be approved by the Council of the Society and at least three officers and/or members of the governing board of the local group would have to be Fellows (or Full Members) of the National Society. Each local section was to collect $1.00 per year less than the regular subscription price of the Newsletter from its local members not Fellows or members of the National Society ($1.50 per member for 1956). Such funds were to be forwarded to the Treasurer of the National Society along with the names and addresses of their members to receive the Newsletter of the Society. The local organization was also to provide the Secretary of the Gerontological Society annually with a complete list of its members and officers.

Applications for affiliation with the Gerontological Society submitted by the Western Gerontological Society and the Florida Council on Aging were approved at the 1956 meeting and renewed at the 1957 meeting. It was decided that members of affiliate and associate groups should be admitted to general membership in the Gerontological Society with annual dues of $1.50 per member and with the right to vote* at the Business Meetings of the Gerontological Society, a subscription to the Newsletter to be included. Individual membership cards were not to be issued to individuals in this category, but their names were to be included in the printed membership list whenever it was published.

A statement of Policy on Affiliate Organizations and Local Chapters was adopted at the 1957 meeting (published in this issue, page 88).

Charters of affiliate groups are renewable annually by the Council.

Grants

In addition to the grants of the Josiah Macy, Jr. Foundation previously mentioned several other grants have been received by Gerontological Society, Inc.

Forest Park Foundation

The Forest Park Foundation, which is interested in the field of aging, gave a grant of $1,500 to the Gerontological Society in 1952 in support of the Journal of Gerontology. This was followed by an allocation of $2,500 in 1953, $2,500 each in 1954 and 1955, $3,500 in 1956, and $4,000 in 1957, totaling $16,500 as of 1957.†

The Forest Park Foundation's generous grants have enabled the Journal of Gerontology to publish considerably more papers than would otherwise have been possible, have aided in the publication of the Index to Current Periodical Literature, and have made possible larger issues of the Newsletter.

Glendorn Foundation

The Council approved the acceptance of a grant ($7,000) from the Glendorn Foundation to finance a conference on the chemistry of blood vessels with special reference to age changes. This was subsequently modified to provide that the grant would cover honoraria for contributors to a critical review of the chemistry of the arterial wall to be edited by A. I. Lansing.

An additional grant of $5,000 was given to the Gerontological Society in support of four symposia at the Cleveland meeting, Assessment of Biological Mechanisms in Aging, Assessment of Social Welfare Services for the Aging and the Aged, Assessment of Health of the Aging, and Assessment of Mental and Social Health of the Elderly. Selected papers from these symposia will be published by the Journal of Gerontology.

National Institutes of Health

The Council approved the appointment of a Research Committee to draw up specific plans and programs for furthering gerontologic research. One of the functions of this Committee was to serve in an advisory capacity to governmental and other agencies responsible for the distribution of research funds. Dr. Lansing was named Chairman of this Committee, which was subsequently divided into a Sub-Committee on Biology and Medicine under the Chairmanship of Dr. Lansing and a Sub-Committee on Psychological and Social Sciences under the Chairmanship of Dr. J. E. Anderson. Dr. Lansing was also Chairman* of the parent Committee, with J. E. Anderson, R. J. Havighurst, and J. E. Kirk as members. The Sub-Committee on Biology and Medicine met twice in 1956 and twice in 1957 to draw up recommendations of the needs in research training in gerontology, to aid in the development of a policy for expediting research in aging, and to define the term aging itself. Two of the meetings were financed by part of a grant of $5,000 from the National Institutes of Health.

A survey on university research on aging, financed by the grant, was conducted by Dr. Kirk. Six hundred ninety-three letters were sent to various university departments and 208 replies were received (covering 189 subjects).

The Program Chairman for 1957, Dr. J. E. Birren, arranged for a grant from the National Institutes of Health to cover the expenses involved in a Symposium on European Gerontology held at the Cleveland meeting. The papers resulting from this symposium will be published as a supplement to the Journal of Gerontology also under this grant.

Membership in the Gerontological Society

1946	80	1952	870
1947	127	1953	950
1948	179	1954	1140
1949	283	1955	1151
1950	378	1956	1208
1951	606	1957	1560

* This provision was rescinded at the 1957 meeting.
† A grant of $4,000 was also received for 1958.

* Dr. J. E. Anderson was appointed Chairman of the parent Committee for 1958.

APPENDIX A—MEETINGS OF GERONTOLOGICAL SOCIETY, INC.

May 18, 1945—Meeting of the Incorporators, New York City

Council and Corporation

1st—June 15, 1945, New York City
2nd—November 14, 1945, New York City

Annual Meetings of the Council and Corporation

1st—February 17, 1946, New York City
2nd—February 2, 1947, New York City
3rd—February 9, 1948, New York City
4th—January 8, 1949, New York City
Special Meeting—November 5, 1949, Chicago
5th—November 12, 1950, St. Louis
6th—September 10, 1951, St. Louis
7th—September 6, 1952, Washington, D. C.
8th—August 25, 1953, San Francisco
9th—December 29, 1954, Gainesville
10th—October 28, 29, 1955, Baltimore
11th—November 7, 8, 1956, Chicago
12th—October 30—November 1, 1957, Cleveland

Business Meetings of the Society

Annual—February 18, 1946, New York City
February 4, 1947, New York City
1st annual—January 9, 1949, New York City
2nd annual—November 5, 1949, Chicago
3rd annual—November 12, 1950, St. Louis
4th annual—September 12, 1951, St. Louis
5th annual—September 7, 1952, Washington, D. C.
6th annual—August 26, 1953, San Francisco
7th annual—December 30, 1954, Gainesville
8th annual—October 28, 1955, Baltimore
9th annual—November 9, 1956, Chicago
10th annual—November 2, 1957, Cleveland

Scientific Meetings of the Society

1st—January 8-9, 1949, Hotel Commodore, New York City
2nd—November 5-6, 1949, Hotel Knickerbocker, Chicago (in cooperation with the American Society for the Study of Arteriosclerosis)
3rd—November 12-13, 1950, St. Louis
4th—September 9-14, 1951, Hotel Jefferson, St. Louis (in conjunction with the Second Congress of the International Association of Gerontology)
5th—September 5-7, 1952, Hotel Willard, Washington, D. C.
6th—August 25-27, 1953, Hotel Mark Hopkins, San Francisco
7th—December 28-30, 1954, University of Florida, Gainesville
8th—October 27-29, 1955, Hotel Sheraton, Baltimore
9th—November 8-10, 1956, Hotel Hamilton, Chicago
10th—October 31-November 2, 1957, Hotel Cleveland, Cleveland

APPENDIX B—COUNCIL MEMBERS, GERONTOLOGICAL SOCIETY, INC., 1945-1957

The names of officers and Council members are listed after the meeting at which they were elected to serve.

The officers and members of the Executive Committee of the Club for Research on Ageing, constituted the first Council:

W. deB. MacNider,* Chairman
E. V. Cowdry
A. B. Hastings
R. A. Moore
H. S. Simms
E. J. Stieglitz, Secretary

1945, First Meeting of the Council & Corporation, New York:

W. deB. MacNider,* President
R. A. Moore, Treasurer
E. J. Stieglitz, Secretary

1946, 1st Annual Council and Annual Business Meeting, New York

President, R. G. Hoskins
President-elect, L. K. Frank
Treasurer, R. A. Moore
Secretary, H. S. Simms

Biological Research
W. deB. MacNider* 3 years
E. V. Cowdry, 2 years
E. T. Engle, 1 year

Medical Research
J. C. Aub, 3 years
E. J. Stieglitz, 2 years
W. Bauer, 1 year

Social Sciences
W. R. Miles, 3 years
E. J. Stieglitz, Secretary at meeting

1947, 2nd Annual Council and Annual Business Meeting, New York:

President, L. K. Frank
President-elect, J. C. Aub
Treasurer, R. A. Moore (and Editor)
Secretary, H. S. Simms

Medical Research
E. J. Stieglitz to 1948
E. Shorr* to 1949 (2 years)
W. Bauer to 1950 (3 years)

Biological Research
E. V. Cowdry to 1948
W. deB. MacNider* to 1949
N. W. Shock to 1950

General
E. W. Burgess to 1948 (1 year)
W. R. Miles to 1949
W. Malamud to 1950
H. S. Simms, Secretary at meeting

* Deceased

1948, 3rd Annual Council Meeting, New York:

President, J. C. Aub
President-elect, C. M. McCay
Treasurer, R. A. Moore (and Editor)
Secretary, H. S. Simms

Medical Research
E. Shorr* to 1949
W. Bauer to 1950
F. D. Zeman to 1951

Biological Research
W. deB. MacNider* to 1949
N. W. Shock to 1950
G. B. Wislocki* to 1951

General
W. R. Miles to 1949
W. Malamud to 1950
E. W. Burgess to 1951

1949, 4th Annual Council and 1st Annual Business Meeting, New York:

President, C. M. McCay
President-elect, C. J. Van Slyke
Treasurer and Editor, R. A. Moore
Secretary, H. S. Simms

Medical Research
W. Bauer to 1950
F. D. Zeman to 1951
J. C. Aub to 1952

Biological Research
N. W. Shock to 1950
G. B. Wislocki* to 1951
O. H. Lowry to 1952

General
W. Malamud to 1950
E. W. Burgess to 1951
G. E. Johnson to 1952

1949, Special Council and 2nd Annual Business Meeting, Chicago:

President, C. J. Van Slyke
President-elect, R. A. Moore
Treasurer, J. E. Kirk
Editor, R. A. Moore
Secretary, H. S. Simms

Medical Research
F. D. Zeman to 1951
J. C. Aub to 1952
E. Shorr* to 1953

Biological Research
G. B. Wislocki* to 1951
O. H. Lowry to 1952
N. W. Shock to 1953

General
E. W. Burgess to 1951
G. E. Johnson to 1952
O. A. Randall to 1953

1950, 5th Annual Council and 3rd Annual Business Meeting, St. Louis

President, R. A. Moore
President-elect, E. W. Burgess
Treasurer, J. E. Kirk
Editor, J. E. Kirk
Secretary, N. W. Shock

Medical Research
J. C. Aub to 1951
E. Shorr* to 1952
E. L. Bortz to 1953

Biological Research
O. H. Lowry to 1951
G. E. Wakerlin to 1952
W. Andrew to 1953

General
G. E. Johnson to 1951
O. A. Randall to 1953
O. J. Kaplan to 1953

1951, 6th Annual Council and 4th Annual Business Meeting, St. Louis:

President, E. W. Burgess
President-elect, E. V. Cowdry
Treasurer and Editor, J. E. Kirk
Secretary, N. W. Shock

Medical Research
E. Shorr* to 1952
E. L. Bortz to 1953
R. A. Moore to 1954

Biological Research
G. E. Wakerlin to 1952
W. Andrew to 1953
A. I. Lansing to 1954.

General
O. A. Randall to 1952
O. J. Kaplan to 1953
C. Tibbitts to 1954

1952, 7th Annual Council and 5th Annual Business Meeting, St. Louis:

President, E. V. Cowdry
President-elect, A. J. Carlson*
Secretary, N. W. Shock
Treasurer and Editor, J. E. Kirk

Biological Sciences
W. Andrew through 1953
A. I. Lansing through 1954

Clinical Medicine
E. L. Bortz through 1953
R. A. Moore through 1954

Psychology and Social Sciences
O. J. Kaplan through 1953
C. Tibbitts through 1954

Social Work and Administration
G. F. McCoy through 1954
G. Bugbee through 1955

1953, 8th Annual Council and 6th Annual Business Meeting, San Francisco:

President, A. J. Carlson*
President-elect, O. A. Randall
Secretary, N. W. Shock
Treasurer and Editor, J. E. Kirk

Biological Sciences
A. I. Lansing through 1954
J. A. Hamilton through 1956

Clinical Medicine
R. A. Moore through 1954
J. T. Freeman through 1956

Psychology and Social Sciences
C. Tibbitts through 1954
W. T. Donahue through 1956

Social Work and Administration
G. F. McCoy through 1954
G. Bugbee through 1956 (replaced by J. Weil)

1954, 9th Annual Council and 7th Annual Business Meeting, Gainesville:

President, O. A. Randall
President-elect, W. B. Kountz
Secretary, N. W. Shock
Treasurer and Editor, J. E. Kirk

Biological Sciences
J. A. Hamilton through 1956
H. S. Simms through 1957

* Deceased

Clinical Medicine
J. T. Freeman through 1956
A. A. Hellbaum through 1957

Psychological and Social Sciences
W. T. Donahue through 1956
J. E. Birren through 1957

Social Work and Administration
J. Weil through 1956
F. E. Vickery through 1957

General
G. F. McCoy through 1956
O. J. Kaplan through 1957

1955, 10th Annual Council and 8th Annual Business Meeting, Baltimore:

President, W. B. Kountz
President-elect, R. J. Havighurst
Secretary, N. W. Shock
Treasurer and Editor, J. E. Kirk

Biological Sciences
J. A. Hamilton through 1956
H. S. Simms through 1957

Clinical Medicine
J. T. Freeman through 1956
A. A. Hellbaum through 1957

Psychological and Social Sciences
W. T. Donahue through 1956
J. E. Birren through 1957

Social Work and Administration
J. Weil through 1956
F. E. Vickery through 1957

General
O. J. Kaplan through 1957
W. M. Beattie through 1958

1956, 11th Annual Council and 9th Annual Business Meeting, Chicago:

President, R. J. Havighurst
President-elect, A. I. Lansing
Secretary, N. W. Shock
Treasurer, J. E. Kirk

Biological Sciences
H. S. Simms through 1957
W. Andrew through 1959

Clinical Medicine
A. A. Hellbaum through 1957
R. T. Monroe through 1959

Psychological and Social Sciences
J. E. Birren through 1957
R. W. Kleemeier through 1959

Social Work and Administration
F. E. Vickery through 1957
L. Kuplan through 1959

General
O. J. Kaplan through 1957
W. M. Beatlie, Jr. through 1958

1957, 12th Annual Council and 10th Annual Business Meeting, Cleveland:

President, A. I. Lansing
President-elect, L. Kuplan
Secretary, N. W. Shock
Treasurer, J. E. Kirk

Biological Sciences
W. Andrew through 1959
N. M. Sulkin through 1960

Clinical Medicine
R. T. Monroe through 1959
L. Gitman through 1960

Psychological and Social Sciences
R. W. Kleemeier through 1959
Ethel Shanas through 1960

Social Welfare
B. L. Grossmann through 1959
J. Kaplan through 1960

General Membership Division
W. M. Beattie, Jr. through 1958
Helen Zollinger through 1960

Affiliate Organizations Division
H. E. Jones through 1960

Chairman, Research and Fellowships Committee
J. E. Anderson through 1958

APPENDIX C—REGISTRY OF GERONTOLOGY

The idea of a Registry of Gerontology was advanced by W. W. Jetter of Harvard University in 1945. It was his thought that "if the gross material from autopsies on unusually old bodies were submitted to such a central organization, considerably more information of value might be obtained than would be the case if the examination were to be conducted by the individual pathologist who sees only an isolated case at infrequent intervals."

At a meeting of the Council of the Gerontological Society on November 14, 1945, the following were appointed as members of the Committee to investigate the activation of the Registry of Gerontology; Jean Oliver (Chairman), C. Hartman, W. W. Jetter, E. V. Cowdry, the Director, or someone designated by the Director of the Army Institute of Pathology, ex officio, and the President of the Gerontological Society, ex officio.

At the second meeting of the Council (Feb. 2, 1947), Dr. MacNider appointed the following members of the Society to constitute the Registry of Gerontology of the American Registry of Pathology: Jean Oliver, Chairman, R. A. Moore, C. J. Hartman, W. W. Jetter, E. V. Cowdry, the Director, or someone designated by the Director of the Army Institute of Pathology, ex officio (Col. J. E. Ash), and the President of the Society, ex officio (R. G. Hoskins).

At the fourth Council meeting (January 8, 1949) Col. Ash discussed the activities of the American Registry of Pathology. It was agreed that the Gerontological Society should make use of the facilities of this Registry through a special commitee appointed for this purpose and that it should contribute $200 toward its support for the coming year. At the business meeting, Dr. G. Klinck discussed the activities of the American Registry of Pathology and pointed out ways in which they might cooperate in the collection of material related to gerontology. It was voted that Gerontological Society should support the activities of the Registry.

It was recommended that both moral and financial support of the Registry be continued but that the recommended financial contribution not be paid until there were a significant amount of material in the Registry. The Treasurer was authorized to pay a sum not exceeding $300 in support of the Registry.

The Committee under the Chairmanship of G. B. Wislocki (W. W. Jetter and W. deB. MacNider) presented a report to the Council on November 5, 1949. The report stated that in 1945, the Registry of Gerontologic Pathology was organized under the auspices of the Society—the function of the Registry was to collect material which would be made available to people interested in investigation or teaching in the subject of gerontology. In 1949, the Council appointed a Committee to investigate the desirability of activating the Gerontology Registry and the manner in which this activation should be effected. The main question considered by this Committee was the type of material that should be collected. According to the report, "Gerontology is the study of the phenomena of old age. Death during the senile state may be caused by widely diversified types of degenerative and infectious diseases that are also found at other age periods. Many of these diseases already constitute the main focus of attention for other already fully established and functioning registries. Attention should be focused primarily upon the 'normal' morphology of aging. Comparison of senile tissues with material obtained from young people may lead to more definitive information regarding the senile state and how and why it comes about. The specific disease process or processes that may have been immediately responsible for death is regarded as being of secondary importance unless there appears to be some connection with the aging process per se."

The Committee recommended that the Registry be activated and that the primary purpose should be the collection and processing of materials from old people and animals, the material to be filed according to both the individual organ or tissue and the decade of life. For comparison, material from younger people and animals would also be collected and filed in a corresponding manner. The Registry would be made the repository for material illustrating the changes of age and senility in wild and domesticated animals and material derived from animal experiments designed to analyze the roles of diet and endocrine factors in the process of aging would also be collected by the Registry.

In his report in November, 1950, W. C. Hueper, then Chairman of the Committee, recommended activation of the Registry, and in 1951 Dr. Hueper reported that no further progress had been made. President Moore recommended that the Committee be continued.

The sum of $250 was paid to the Registry September 27, 1945 and $200 was paid September 26, 1949.

INDEX TO CURRENT PERIODICAL LITERATURE

NATHAN W. SHOCK

Gerontology Branch, National Heart Institute, National Institutes of Health

THE SUBJECT categories are those in *A Classified Bibliography of Gerontology and Geriatrics* by Nathan W. Shock published by Stanford University Press, Stanford, California (1951). Only major headings are used and the Roman numerals correspond to those given in the bibliography. In so far as possible, references are classified according to organ systems. Thus, most of the material on Geriatrics will be found under the organ system involved in the disease. Cross references are indicated by number at the end of each section. When available, abstract references are given (*B.A.—Biological Abstracts: P.A.—Psychological Abstracts*, and *P.I.—Population Index*). Abbreviations for journals are those used in *A World List of Scientific Periodicals Published* in the years 1900-1933, 2nd Edition. For journals not listed, abbreviations were devised according to the general rules used in the above source. It is impossible to cover all journals and list all papers concerned with aging and the aged. Authors and publishers are requested to call attention to publications or to send reprints to the Gerontology Branch, Baltimore City Hospitals, Baltimore 24, Maryland. The assistance of the Forest Park Foundation, Peoria, Illinois, in the preparation of these materials is gratefully acknowledged.

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